

# NAEMSP ABSTRACTS

## ABSTRACTS FOR THE 2013 NAEMSP SCIENTIFIC ASSEMBLY

These are the abstracts for the National Association of EMS Physicians Scientific Assembly, Bonita Springs, Florida, January 10–12, 2013. **Key words:** EMS; out-of-hospital; emergency medical services; abstracts; National Association of EMS Physicians

### 1. SYSTEMWIDE REGIONALIZATION OF EMS AND HOSPITAL CARE FOR OUT-OF-HOSPITAL CARDIAC ARREST: ASSOCIATION WITH IMPROVED SURVIVAL AND NEUROLOGIC OUTCOMES

Daniel Spaite, Bentley Bobrow, Uwe Stolz, Vatsal Chikani, Will Humble, Terry Mullins, Margaret Mullins, J. Steven Stapczynski, Karl Kern, Gordon Ewy, Arizona Emergency Medicine Research Center

**Background.** Some specialized postarrest interventions for out-of-hospital cardiac arrest (OHCA) have been shown to improve outcomes. We evaluated the impact of implementing a voluntary, comprehensive, statewide system of designated cardiac receiving centers (CRCs) and prehospital (emergency medical services [EMS]) triage/bypass protocols on OHCA outcomes. We previously reported preliminary results, but this report includes hospitals from across the state, much larger numbers, and neurologic outcomes. **Methods.** In December 2007, the Arizona Department of Health Services initiated a program of designating hospitals as CRCs based on ability to provide American Heart Association (AHA) Guideline postarrest therapy and 24-hours-a-day/sevendays-a-week (24/7) percutaneous coronary interventions. In addition, the State EMS Council approved protocols allowing EMS to bypass local hospitals to take patients with return of spontaneous circulation (ROSC) to CRCs if the expected increase in transport interval was <15 minutes. Design: Prospective before/after observational study comparing OHCA patients admitted to CRCs during the six months prior to implementation (Phase 1 [P1]) with those brought after (P2). Outcomes: Survival to hospital discharge (cohorts: all rhythms, shockable rhythms) and neurologic status (good = cerebral performance category of 1 or 2). Statistics: Fisher's exact test, multiple logistic regression,  $\alpha < 0.05$ . **Results.** Over 150 EMS agencies participated and 31 hospitals were designated as CRCs (December 2007 to December 2010; serving ~80% of Arizona's population). Four hundred forty OHCA patients (age  $\geq 18$  years) were transported to CRCs in P1 and 1,734 in P2. All-rhythm survival increased from 8.9% to 14.4% (adjusted odds ratio [aOR] = 2.14 [95% confidence interval (CI): 1.43, 3.21;  $p < 0.01$ ]). Survival with CPC 1/2 increased from 5.9% to

8.9% (aOR 2.12; 1.30, 3.45;  $p < 0.01$ ). For shockable rhythms, survival increased from 19.1% to 33.0% (aOR 2.40; 1.48, 3.90;  $p < 0.01$ ) and CPC 1/2 increased from 15.0% to 22.8% (aOR 2.12; 1.22, 3.69;  $p < 0.01$ ). **Conclusions.** Implementation of a statewide system of CRCs and EMS bypass was independently associated with significant increases in rates of overall survival (61.8% relative increase) and good neurologic status (+50.8%). In addition, survival among those with shockable rhythms improved (+72.8%), as did their rate of good neurologic outcome (+52.0%). Implementation of EMS bypass protocols and regionalization of postarrest care across a vast demography is feasible and, in this study, was associated with dramatic improvements in survival and neurologic outcome.

### 2. WHAT IS THE OPTIMAL CHEST COMPRESSION DEPTH DURING OUT-OF-HOSPITAL CARDIAC ARREST RESUSCITATION OF ADULT PATIENTS?

Ian Stiell, Siobhan Brown, Clifton Callaway, Graham Nichol, Tom Aufderheide, Sheldon Cheskes, Christian Vaillancourt, David Hostler, Daniel Davis, Ahamed Idris, James Christenson, Laurie Morrison, John Stouffer, Cliff Free, University of Ottawa

**Background.** The 2010 American Heart Association/International Liaison Committee on Resuscitation (AHA/ILCOR) recommendations suggested an increase in cardiopulmonary resuscitation (CPR) compression depth for adults, with a target >50 mm and no upper limit. This target is based on limited evidence and, hence, we sought to determine the optimal compression depth range for adult patients. **Methods.** We studied emergency medical services-treated out-of-hospital cardiac arrest patients from the Resuscitation Outcomes Consortium (ROC) PRIMED clinical trial and Epistry-Cardiac Arrest database for whom electronic CPR compression depth data were available, from June 2007 to December 2010. We calculated anterior chest wall depression in millimeters for each minute of CPR. We controlled for 10 covariates, including compression rate and calculated adjusted odds ratios for survival to hospital discharge, 24-hour survival, and any return of spontaneous circulation (ROSC). Smoothing splines were used to explore the relationship between average compression depth and outcome. **Results.** We included 9,142 adult patients from nine U.S. and Canadian cities with these characteristics: mean age 67.5 years; male 64%; bystander witnessed 44%; bystander CPR 42%; initial rhythms ventricular fibrillation/ventricular tachycardia 24%, pulseless electrical activity 20%, asystole 49%, and other nonshockable rhythm 6%; and outcomes ROSC 31.3%, one-day survival 22.8%, and survival to hospital discharge 7.3%. For all patients, the mean compression rate was 108 per minute; the mean compression fraction was 0.68; and

the mean compression depth was 41.9 mm, with the following ranges: <38 mm 37%, 38–51 mm 45%, and >51 mm 18%. The adjusted odds ratios for survival to discharge, with depth >51 mm as reference, were <38 mm, 0.69 (95% confidence interval [CI] 0.53, 0.90) and 38–51 mm, 1.03 (0.81, 1.30). Results were similar for the intermediate outcomes of ROSC and one-day survival. Covariate-adjusted spline curves revealed that the maximum survival was associated with a depth of 45.8 mm, followed by a decline in survival by 50 mm (optimal interval 44–49 mm). We also found no differences in the spline curves between males and females. **Conclusions.** This study found that more than one-third of patients received very low compression depth. The optimal CPR compression depth for survival appears to be 46 mm (44–49) for both male and female adults, but falls off after 50 mm. These findings conflict with the 2010 international guideline recommendations.

### 3. OUTCOMES OF MILD THERAPEUTIC HYPOTHERMIA IN OUT-OF-HOSPITAL CARDIAC ARREST: A NATIONWIDE RETROSPECTIVE ANALYSIS

Won Pyo Hong, Sang Do Shin, Eui Jung Lee, Young Sun Ro, Joo Yeong Kim, Chang Bae Park, Kyoung Jun Song, Dae Han Wi, Seoul National University College of Medicine

**Background.** Although heavily emphasized, the effect of therapeutic hypothermia (TH) has been evaluated only in well-controlled hospital-based trials. This study aimed to determine whether mild TH was associated with improved outcomes in out-of-hospital cardiac arrest (OHCA) on a nationwide scale. **Methods.** We used a national OHCA cohort database from January 2008 to December 2010; we included all emergency medical services (EMS)-treated adult patients with OHCA of presumed cardiac etiology. Multivariable logistic regression analysis was used to determine the effect of TH. Subgroup analyses were performed regarding initial presenting electrocardiogram rhythm (shockable vs. nonshockable). We extracted propensity-matched samples to control for selection bias, and the propensity-matched cohort was also analyzed by multivariable logistic regression. **Results.** Among 64,155 EMS-assessed OHCA patients with available outcome data, 44,794 (69.8%) were adults with presumed cardiac etiology; 4,557 (10.2%) of these patients survived to admission and were selected for the final analysis. The survival-to-discharge rate was higher in the TH group than in the non-TH group (53.6% vs. 33.4%,  $p < 0.001$ ). A good neurologic outcome was also higher in the TH group than the non-TH group (18.3% vs. 10.3%,  $p < 0.001$ ). The adjusted odds ratios (ORs) of the TH versus the non-TH group were 1.78 (95% confidence interval [CI] 1.41–2.26) for survival to

discharge and 1.31 (95% CI 0.94–1.82) for good neurologic outcome. In subgroup analysis, the adjusted ORs of TH for survival to discharge were 2.00 (95% CI 1.13–3.55) and 1.60 (95% CI 1.24–2.07) for shockable rhythm and nonshockable rhythm, respectively. The adjusted ORs of TH for good neurologic outcome were 1.81 (95% CI 1.04–3.13) and 0.89 (95% CI 0.59–1.33), respectively. In the propensity score-matched cohort, the adjusted ORs of hypothermia were 1.83 (95% CI 1.33–2.50) for survival to discharge and 1.20 (95% CI 0.76–1.88) for good neurologic outcome. **Conclusions.** Mild therapeutic hypothermia improved survival to discharge and neurologic outcomes on a nationwide scale. The effect was increased when the initial rhythm was shockable.

#### 4. DISPATCHER-ASSISTED BYSTANDER CARDIOPULMONARY RESUSCITATION IN A METROPOLITAN CITY: A BEFORE-AND-AFTER POPULATION STUDY

Sang Do Shin, Joo Yeong Kim, Chang Bae Park, Kyoung Jun Song, Seoul National University Hospital

**Background.** The goal of this study was to determine the effect of dispatcher-assisted bystander cardiopulmonary resuscitation (D-CPR) on the outcomes of out-of-hospital cardiac arrest (OHCA). **Methods.** This study was performed in an emergency medical services (EMS) system with a single-tiered basic to intermediate service level and with about 65 destination hospitals in a metropolitan city with a population of 10 million. All EMS runs are dispatched by a single centralized and physician-supervised center. An OHCA database including outcomes and demographic, Utstein, EMS, and hospital factors was populated from a dispatch center registry and EMS run sheets, and followed by medical record review for outcome survey during 2009 to 2011. Cases with unknown outcome, patient age less than 15 years, and noncardiac causes were excluded. The intervention was the novel D-CPR method (in the 2010 American Heart Association guideline), which was implemented in January 2011. The primary and secondary end points were survival to discharge and good neurologic outcome (cerebral performance category 1 to 2). Adjusted odds ratios (ORs) and 95% confidence intervals (95% CIs) for estimating the effect size of the D-CPR period compared with the previous two years were calculated for outcomes, adjusting for potential predictors (age, gender, witness, response time, transport time, initial electrocardiogram, and emergency department level [1 to 4]). **Results.** There were 8,143 EMS-assessed adult OHCA with presumed cardiac cause. Of these, bystander CPR was performed for 5.7% of the patients (148/2,600) in 2009, 6.7% (190/2,857) in 2010, and 37.8% (1,016/2,686) in 2011 ( $p < 0.001$ ). The survival to discharge was 7.1% in 2009, 7.1% in 2010, and 9.5% in 2011 ( $p = 0.001$ ). Good neurologic outcome was 2.1% in 2009, 2.0% in 2010, and 3.6% in 2011 ( $p < 0.001$ ). The adjusted ORs (95% CIs) for survival to discharge for 2011 and 2010 compared with 2009 were 1.53 (1.24–1.90) in 2011 and 1.16 (0.93–1.45) in 2010. The adjusted ORs (95% CIs) for good neurologic outcome for 2011 and 2010 compared with 2009 were 2.12 (1.47–3.05) in 2011 and 1.21 (0.81–1.80) in 2010. **Conclusions.** In this metropolitan before-and-after study, an EMS intervention of a D-CPR protocol showed significant increase of bystander CPR and resulted in improved survival and neurologic outcome.

#### 5. COMPARISON OF SUCCESS RATES BETWEEN TWO VIDEO LARYNGOSCOPE SYSTEMS USED IN A PREHOSPITAL CLINICAL TRIAL

Aaron Burnett, Ralph Frascone, Sandi Wewerka, Samantha Kealey, Zabrina Evens, Kent Griffith, Joshua Salzman, Regions Hospital EMS

**Background.** To date, no clinical trial has compared the paramedic placement success rates of two different video laryngoscope (VL) systems in a nonsimulation setting. **Methods.** This institutional review board-approved, multi-agency, prospective, prehospital, nonrandomized, crossover trial compared the success rates and complications for two VL systems (Storz CMAC<sup>®</sup>, Macintosh #4 blade; King VISION<sup>™</sup>, Size 3). The providers completed initial didactic and hands-on training, were grouped by agency into two treatment arms based on call volume, and were randomly assigned the initial treating VL system. Patient inclusion criteria were: 1)  $\geq 18$  years old, 2) required advanced airway management per standardized patient care guidelines, and 3) treating provider was trained in the use of VL. Patients with supraglottic airway placement prior to arrival were excluded. After six months of telephone data collection (available 24 hours a day/seven days a week) following a placement attempt, the VL systems were crossed over for the remaining four months. Patient (age, gender, body mass index [BMI], race, ethnicity, primary impression, call type, and difficult airway) and provider (age, gender, years of experience,  $>1$  VL placement during the study period, agency, and phase) demographics were compared between groups. Overall success rates (successful placement/number of patients), success rates by attempt (successful placement/total number of attempts), and complications were compared between treatment groups using exact logistic regression. The Cormack-Lehane (CL) score for each attempt was also analyzed for impact on success rates using a generalized linear mixed-effects model. **Results.** Between October 2011 and August 2012, a total of 97 patients were treated by 55 of 186 (30%) trained providers. There were no differences in patient or provider demographics between groups. The overall success rate was significantly higher for the CMAC group (79% vs. 53%, odds ratio [OR] = 3.39;  $p = 0.008$ ), as was the success by attempt rate (58.4% vs. 32.8%, OR = 2.88;  $p = 0.004$ ). The provider-reported rates and absolute numbers of complications were similar between treatment groups ( $p = 0.16$ ;  $p = 0.12$ ). The most frequent complication reported was vomiting during insertion (7.2%). Higher CL scores predicted lower odds of success (OR = 0.379,  $p < 0.0001$ ). **Conclusions.** Airway management with the CMAC resulted in a significantly higher success rate, although the rate is similar to previously published ETI success rates.

#### 6. EVALUATION OF THE IMPLEMENTATION OF THE REVISED ACUTE STROKE MEDICAL REDIRECT PARAMEDIC PROTOCOL (ASMRPP) IN URBAN AND RURAL SETTINGS

Ian Stiell, Kristy Smaggus, Catherine Clement, Michael Sharma, Doug Socha, Marco Sivilotti, Albert Jin, Jeffrey Perry, Jim Lumsden, Cally Martin, Mark Froats, Richard Dionne, John Trickett, University of Ottawa

**Background.** The regional Acute Stroke Medical Redirect Paramedic Protocol (ASMRPP) stroke-redirect guidelines were recently revised to allow emergency medical services (EMS) to bypass the nearest hospital for designated stroke centers if total transport time would

be  $<2$  hours and total time from symptom onset  $<3.5$  hours. We sought to evaluate the impact and effectiveness of implementing the revised ASMRPP within a large urban and rural region. **Methods.** We conducted a 12-month multicenter, prospective cohort study involving all prehospital patients presenting with possible acute stroke. Participating were 1,000 basic life support and 300 advanced life support paramedics of nine land EMS agencies, operating in a catchment area of 10 rural counties and five cities (total population of 1.7 million, total area 15,000 square miles), with 22 acute care hospitals and two university hospital stroke centers. Paramedics completed a record form for each case and, initially, a second paramedic independently completed the form. Outcomes and data analyses included redirect sensitivity and specificity, patient outcomes, adverse events, interrater reliability with the kappa statistic, and EMS and hospital impact. **Results.** We enrolled 987 eligible patients: male 50.7%, mean age 73.8 years (range 16–101), met redirect criteria 52.9%, mean total prehospital time 43.2 minutes (range 14–165), and prehospital adverse events 12.6%. Of the 503 who met redirect criteria and were transported to a stroke center, 76.7% had a stroke code activated, 51.9% had a final diagnosis of stroke, 21.9% received thrombolysis, 7.2% had adverse events in the emergency department (ED), 2.6% were repatriated to their local hospital from the ED, and 89.7% survived to discharge. Their mean National Institutes of Health (NIH) Stroke Scale score was 8.2. For all 562 patients transported to a stroke center, the paramedics were 98.0% sensitive and 30.4% specific for stroke code activation in the ED. The paramedics had excellent interrater agreement, with kappa values ranging from 0.59 to 0.90 for redirect criteria, from 0.84 to 1.0 for contraindication criteria, and 0.94 for need to transport to a stroke center. **Conclusions.** In this large urban/rural assessment of the ASMRPP stroke-redirect guidelines, paramedics were highly accurate in identifying patients who needed urgent stroke center transport and showed excellent interrater agreement for criteria. This protocol benefits patients without unduly burdening EMS or hospitals.

#### 7. MODIFIED RANKIN SCORE AT HOSPITAL DISCHARGE IS PREDICTIVE OF ONE-YEAR NEUROLOGIC FUNCTION IN SURVIVORS AFTER CARDIAC ARREST

Marvin Wayne, David Tupper, Tom Aufderheide, Brian Mahoney, Robert Swor, Robert Domeier, Michael Olinger, Richard Holcomb, Cindy Setum, Ralph Frascone, Whatcom County EMS

**Background.** A randomized multicenter clinical trial compared standard cardiopulmonary resuscitation (S-CPR) with active compression-decompression CPR plus an inspiratory impedance threshold device (ACD+ITD) in patients with nontraumatic, out-of-hospital cardiac arrest (OHCA) from a presumed cardiac cause. Survival to hospital discharge (HD) with favorable neurologic function, defined as a modified Rankin score (MRS)  $\leq 3$ , and one-year survival were greater in the ACD+ITD group. We evaluated the concordance of the primary end point, HD with MRS  $\leq 3$ , with multiple secondary neurologic end points assessed at one year. **Methods.** A total of 813 patients were enrolled in the S-CPR group and 842 in the ACD+ITD group. The MRS at HD, and the Cerebral Performance Category Scale (CPC), Overall Performance Category (OPC), Health Utilities Index (HUI), and Cognitive Abilities Screening Instrument

(CASI) assessments were based on responses from consented survivors and known deaths at one year. Neurologic assessments were administered by research staff blinded to the CPR treatment. Survival data were available for 98% of subjects. Fisher's exact test, Pearson chi-square test, Mann-Whitney U test, and t-test for equality of means were used, as applicable, for comparisons. All statistical tests were two-sided, and p-values <0.05 were regarded as significant. **Results.** The MRS ( $\leq 3$  vs.  $> 3$ ) neurologic assessment at HD was highly predictive of whether a patient would be alive with favorable neurologic function in both study groups, assessed using the CPC score ( $> 3$  vs.  $\leq 3$ ) at one year: 35 of 37 (94.6%) subjects in the S-CPR group and 50 of 54 (92.6%) subjects in the ACD+ITD group with MRS  $\leq 3$  at HD had CPC  $> 3$  at one year (98.0% observed agreement, kappa = 0.800,  $p < 0.001$ ). Similar concordance was also shown with overall survival, OPC, HUI, and CASI. **Conclusion.** Neurologic status at the time of HD, as measured by MRS, is highly predictive of long-term neurologic function at one year. This is the first time that the MRS at the time of HD has demonstrated the ability to predict long-term outcomes for patients with OHCA.

#### 8. SURVIVAL FROM HOSPITAL DISCHARGE TO ONE YEAR AFTER OUT-OF-HOSPITAL CARDIAC ARREST: A COMPARISON OF STANDARD CPR VERSUS ACTIVE COMPRESSION-DECOMPRESSION CPR PLUS AN IMPEDANCE THRESHOLD DEVICE

**Robert Swor, Richard Holcomb, Ralph Frascone, Brian Mahoney, Marvin Wayne, Robert Domeier, Michael Olinger, David Tupper, Demetris Yannopoulos, Tom Auferheide, William Beaumont Medical Center**

**Background.** Little is known about the impact of the method of cardiopulmonary resuscitation (CPR) on long-term survival following out-of-hospital cardiac arrest. A recent National Institutes of Health-funded multicenter prospective randomized clinical trial, the ResQtrial, compared standard CPR (S-CPR) versus active compression-decompression CPR plus the use of an impedance threshold device (ACD+ITD). ACD+ITD was associated with a relative 53% increase in survival to hospital discharge with favorable neurologic function for subjects with a cardiac arrest of presumed cardiac etiology, compared with S-CPR. Using data from all patients randomized to one of these two methods of CPR from this trial, we tested the hypothesis that ACD+ITD would improve the likelihood of survival from the time of hospital discharge to one year after cardiac arrest. **Methods.** A total of 1,335 adult patients with nontraumatic out-of-hospital cardiac arrest were enrolled in the S-CPR group and 1,403 in the ACD+ITD group; 134 patients versus 165 patients, respectively, survived to hospital discharge. A Kaplan-Meier analysis was performed for all patients known to be discharged alive from the hospital. Data up to one year after the cardiac arrest were obtained from patient records, patient interviews, and public records. **Results.** Fewer patients in the S-CPR group survived to hospital discharge with modified Rankin score (MRS)  $\leq 3$  (5.7% vs. 7.9%,  $p = 0.03$ ), but the demographic characteristics of survivors were similar between groups. Starting with 100% survival at hospital discharge, survival decreased in both groups over time, but more notably in the S-CPR group. Six months after cardiac arrest, survival rates were 77% in the S-CPR group and 88% in the ACD+ITD group. After

365 days, survival rates were 72% in the S-CPR group and 83% in the ACD+ITD group (log base rank p-value = 0.014). **Conclusions.** The survivors to hospital discharge in the ResQtrial who were treated with ACD+ITD CPR had an absolute 11% greater likelihood of surviving to 365 days after cardiac arrest compared with the patients treated with S-CPR. These data support the hypothesis that increased perfusion during CPR, obtained with the use of ACD+ITD CPR, results in a significantly higher likelihood of long-term survival, regardless of etiology of the nontraumatic cardiac arrest.

#### 9. ASSESSING THE ACCURACY OF COMPUTER ECG INTERPRETATION FOR IDENTIFYING ACUTE MYOCARDIAL INFARCTION

**Amy Kule, Stephanie Hang, Kelly Sawyer, Alfred Burris, Justin Trivax, Robert Swor, Oakland University William Beaumont School of Medicine**

**Background.** Computer interpretation of electrocardiograms (CI-ECG) has assisted in identifying potential ST-segment elevation myocardial infarction (STEMI) to shorten triage time and decrease door-to-balloon time for patients with acute myocardial infarction (AMI). However, literature evaluating computer algorithm accuracy only compares CI-ECG with physician interpretation for STEMI, which provides an imperfect "gold standard" for AMI diagnosis. Our objective was to evaluate the performance characteristics of CI-ECG for coronary artery occlusion using angiography as the gold standard. **Methods.** We examined a retrospective cohort of CI-ECGs obtained from emergency medical services (EMS)-transported adult patients admitted to the catheterization laboratory for suspicion of AMI at a single, large, academic community emergency department. EMS ECGs from January 2006 to February 2011 were reviewed and dichotomized as either "CI-ECG+," defined as "AMI suspected" by computer printout, or "CI-ECG-." Patient demographics and relevant time intervals, including time from EMS ECG until reperfusion (minutes), were assessed for impact on computer accuracy of diagnosis. The primary outcome of "definite AMI" was based on angiographic evidence for acute coronary vessel occlusion or presence of thrombus in a culprit vessel and confirmed by an independent cardiologist. Sensitivity, specificity, and likelihood ratios (LRs) were calculated as measures to evaluate CI-ECG. **Results.** A total of 173 patients were identified, of whom 54% were male, the mean age (range) was 65.7 (35-94) years, and the mean time ( $n = 134$ ) from ECG to reperfusion was 81.9 (standard deviation  $\pm 25.6$ ) minutes. Overall, 73 (42.2%) "CI-ECGs+" and 43 (24.9%) "CI-ECGs-" had coronary occlusion on angiography. Computer accuracy did not differ between groups by gender or time interval from ECG to reperfusion; however, those with CI-ECG+ had a trend toward younger age (mean difference 4.1 years, 95% confidence interval [CI] 0.08-8.06,  $p$ -value 0.046). Performance characteristics of CI-ECG for definite AMI revealed sensitivity 62.9% (95% CI 53.4-71.6); specificity 36.8% (95% CI 24.8-50.7); positive likelihood ratio 0.99 (95% CI 0.78-1.27); and negative likelihood ratio 1.01 (95% CI 0.75-1.35). **Conclusion.** Using coronary angiography as a gold standard, computer interpretation of ECGs poorly identifies coronary artery occlusion. Further work is needed to understand the relative value of CI-ECG versus clinician interpretation of ECG in the diagnosis of coronary artery occlusion.

#### 10. COMPARISON OF THE EFFECTS OF CHEST COMPRESSION BOUT LENGTH ON CORONARY PERFUSION PRESSURE DURING CARDIOPULMONARY RESUSCITATION

**David Salcido, Joshua Reynolds, James Menegazzi, University of Pittsburgh School of Medicine**

**Background.** Periodic reduction in blood flow and pressure associated with interruptions in ventilations during cardiopulmonary resuscitation (CPR) may be detrimental. Continuous or prolonged delivery of chest compressions may maintain higher blood flow and pressure longer, offsetting the physiologic effects of protocolized pauses. **Objective.** To examine the relationship between coronary perfusion pressure (CPP) and duration of uninterrupted chest compressions in a controlled resuscitation model. **Methods.** Five juvenile, mixed-breed domestic swine (28.1 kg  $\pm$  5.4) were sedated with ketamine and xylazine, intubated, and ventilated mechanically. The animals were then anesthetized and paralyzed, and micromanometer-tipped catheters were introduced by cutdown through the right femoral artery and vein into the aorta and right atrium, respectively. Aortic and right atrial pressures were recorded continuously, and the diastolic end-point pressure differential between the two was taken as the CPP. Ventricular fibrillation was induced with a 3-second 100-mA transthoracic shock, followed by 8 minutes without treatment, and then 30:2 mechanical CPR (LUCAS2, Jolife) at a rate of 100 per minute was initiated. Epinephrine and vasopressin were administered after 2 minutes of CPR. At 1, 3, 5, and 7 minutes of CPR, compressions were allowed to go on for one bout of 60 continuous chest compressions, followed by two rescue breaths. The CPP characteristics were compared between each 60-compression bout and the immediate preceding bout. Characteristics included: CPP at compression 30, CPP at the final compression, maximum CPP, mean CPP, CPP difference between the first compression and compression 30, and CPP difference between the first compression and the final compression. The CPP characteristics were compared between 30- and 60-compression bouts over time with repeated-measures analysis of variance using an alpha of 0.05. **Results.** Mean CPP 30-compression values versus mean CPP 60-compression values over all time points were as follows: (6.5, 13.6, 36.1, 28.7) vs. (8.8, 14.2, 34.1, 26.1). Mean CPP characteristics generally increased over time relative to the first minute of CPR ( $p < 0.001$ ). The CPP characteristics did not differ overall between the 30- and 60-compression bouts. **Conclusion.** In a controlled laboratory resuscitation model, doubling the number of uninterrupted compressions from 30 to 60 does not beneficially change CPP characteristics.

#### 11. FREQUENCY OF MANUSCRIPT PUBLICATION FOLLOWING PRESENTATION OF EMS ABSTRACTS AT NATIONAL MEETINGS

**Brian Clemency, Heather Lindstrom, Steven Gurien, Berly Jaison, Jeffrey Thompson, University at Buffalo**

**Background.** Specialized knowledge and a scientific body of literature are the foundation of emergency medical services' (EMS's) recognition as a subspecialty within emergency medicine. EMS research is often presented at national meetings and published in abstract form, but full publication occurs less frequently. The primary goal of our study was to determine the rate at which EMS-related research presented at selected conferences went on to

publication. A secondary goal was the determination of the time to manuscript publication. **Methods.** We conducted a retrospective review of published abstracts from the 2003–2005 national meetings of the American College of Emergency Physicians (ACEP), the Society for Academic Emergency Medicine (SAEM), the National Association of EMS Physicians (NAEMSP), the Association of Air Medical Services (AAMS), and the National Association of EMS Educators (NAEMSE) to identify EMS-related abstracts. We then searched PubMed (www.pubmed.gov) using abstract title key words and authors' names to determine if the study had been published in a PubMed-indexed journal in the time since presentation and abstract publication. **Results.** Abstracts for the five conferences were reviewed for 2003–2005. Six abstracts were excluded because of manuscript publication prior to presentation. Six hundred thirty-five EMS-related abstracts were identified. The total number of EMS abstracts presented and the percentage subsequently published as full manuscripts were: ACEP 128, 48.4%; AAMS 66, 33.3%; NAEMSE 24, 16.7%; NAEMSP 282, 42.9%; and SAEM 135, 53.3%. The overall rate of publication was 44.3%. The average time to publication was 22.2 months (standard deviation 16.5, range 0 to 94 months). **Conclusion.** Fewer than half of the EMS abstracts went on to manuscript publication. This represents missed opportunities for the growth of EMS as a subspecialty.

#### 12. BIOMECHANICAL ANALYSIS OF SPINAL IMMOBILIZATION DURING PREHOSPITAL EXTRICATION: A PROOF-OF-CONCEPT STUDY

Mark Dixon, Joseph O'Halloran, Niamh Cummins, *University College Dublin*

**Background.** In most countries, road traffic collisions (RTCs) are the main cause of cervical spine injuries. There are several techniques in use for spinal immobilization during prehospital extrication; however, the evidence for these is poor. The aim of this study was to establish which rescue technique provides the minimal deviation of the cervical spine from the neutral inline position during the extrication of the RTC patient using biomechanical analysis techniques. **Methods.** A simulated male patient (weight 80 kg, height 180 cm) was fitted with a cervical collar and extricated from a prepared motor vehicle with roof removed and standard emergency medical services safety measures in place. A rescue crew of four firefighter first responders and two paramedics performed eight different extrication techniques. The patient was marked with biomechanical sensors in the midline and in two horizontal planes at the level of the forehead and clavicles, respectively. Relative movement between the sensors was captured via 12 infrared high-speed motion-analysis cameras recording at 200 Hz. A virtual three-dimensional mathematical model was developed from the recorded movement. **Results.** Control measurements were taken from the patient during self-extrication under verbal instruction and movement was recorded of 4.194° left of midline (LOM) to 2.408° right of midline (ROM), resulting in total movement of 6.602°. In comparison, the minimum deviation recorded during equipment-aided extrication (long spinal board and/or extrication device) was movement of 3.365° LOM and 8.352° ROM, resulting in total movement of 11.717°. The maximum deviation recorded during equipment-aided extrication was movement of 1.588° LOM and 24.498° ROM, resulting in total movement of 26.086°. **Conclusions.** Standard extrication techniques cause up to four times more cervical spine movement during extrication than controlled self-extrication.

This pilot demonstrates the need for further multicenter evaluation of current rescue techniques and the requirement to investigate the clinical significance of such movement.

#### 13. DEGRADATION OF BENZODIAZEPINES AFTER 120 DAYS OF EMS DEPLOYMENT

Jason McMullan, Elizabeth Jones, Kurt Denninghoff, Daniel Spaite, Erin Zaleski, Robert Silbergleit, *University of Cincinnati*

**Introduction.** Emergency medical services (EMS) treatment of status epilepticus with benzodiazepines improves outcomes, but it is unclear which benzodiazepine is best suited for use in the EMS environment. There is little evidence published regarding the heat stability of benzodiazepines deployed on active EMS units. This study's objective was to describe the degradation of diazepam, lorazepam, and midazolam as a function of temperature exposure and time over 120 days of storage on active EMS units. **Methods.** Vials of diazepam, lorazepam, and midazolam were distributed to four active EMS units in each of two EMS systems in the U.S. Southwest during the summer of 2011. Medications were placed in study boxes that logged temperature every minute and were stored in EMS units per local agency policy. Two vials of each drug were removed from each box at 30-day intervals and underwent high-performance liquid chromatography in a central laboratory to determine drug concentration, which was compared with labeled concentration. Mean kinetic temperature (MKT) exposure was derived for each sample. Concentrations were analyzed as means with 95% confidence intervals (CIs), and groups were compared with repeated-measures analysis of variance (ANOVA). **Results.** One hundred ninety-two total samples were collected (two samples per four units per city at four time points for each drug). Diazepam and midazolam experienced minimal degradation at each time point. At 120 days, the mean relative concentration (95% CI) of diazepam was 97.0% (95.7–98.2%) and that of midazolam was 99.0% (97.7–100.2%). Lorazepam experienced significant degradation by 60 days (95.6%; 91.6–99.5%), with half of all samples <95% of labeled concentration. The relative concentration of lorazepam was 90.3% (85.2–95.4%) at 90 days and 86.5% (80.7–92.3%) at 120 days. The groups were different at every time point (ANOVA  $p < 0.007$ ). The mean MKT was 30.2°C (95% CI 28.5–31.0°C). Increasing MKT was associated with greater degradation of lorazepam, but not midazolam or diazepam. **Conclusions.** Midazolam and diazepam show, respectively, no or little degradation related to time or temperature over 120 days of deployment in the field in active EMS units. Lorazepam experiences significant and progressive degradation with time at 60, 90, and 120 days, and with increasing MKT exposure.

#### 14. THE INFLUENCE OF PREHOSPITAL HYPOTENSION AND HYPOXIA ON OUTCOMES IN PATIENTS WITH MAJOR TRAUMATIC BRAIN INJURY

Daniel Spaite, Vatsal Chikani, Bentley Bobrow, Michael Sotelo, Bruce Barnhart, Kurt Denninghoff, Joshua Gaither, Chad Viscusi, David Adelson, Duane Sherrill, David Hardin, Uwe Stolz, *Arizona Emergency Medicine Research Center*

**Background.** For major traumatic brain injury (TBI), few studies have evaluated the impact of prehospital hypotension and hypoxia on outcomes other than mortality, and even these have generally been small. We evaluated the impact of prehospital hypotension/hypoxia

on multiple outcomes in TBI patients in a statewide trauma system. **Methods.** The Arizona State Trauma Registry contains EMS and trauma center (TC) data from all trauma patients transported by ~300 emergency medical services (EMS) agencies to eight level I or II TCs in Arizona. Prehospital hypotension (blood pressure [BP] <90 mmHg in adults/children aged ≥10 years) and/or hypoxia (oxygen saturation [O<sub>2</sub> sat] <90%) and various TC outcomes in all moderate/severe TBI cases (Centers for Disease Control and Prevention [CDC] Baffle Matrix Type 1) from January 1, 2007, to December 31, 2011, were evaluated (exclusions: transfers; missing EMS O<sub>2</sub> sat or BP data). Four cohorts were established by presence of hypoxia and/or hypotension: neither, hypoxia only, hypotension only, or both. We compared survival, TC length of stay (LOS), intensive care unit (ICU) LOS, TC charges (\$), and final disposition across cohorts. **Results.** Of 12,475 cases meeting inclusion criteria, 4,757 (38.1%) were missing O<sub>2</sub> sat or BP data, leaving 7,718 cases (neither, 87.4%; hypotension only, 3.6%; hypoxia only, 6.0%; both, 3.0%). The median patient age was 44 years (interquartile range [IQR]: 27, 60; 70.2% male). Mortality was as follows: overall, 12.6%; neither, 7.1%; hypotension only, 24.6%; hypoxia only, 32.5%; both, 82.6% ( $p < 0.00$ , all comparisons). The adjusted odds ratios (aORs) for death (reference = neither) were as follows: hypotension only, 2.32 (95% confidence interval [CI]: 1.66, 3.23); hypoxia only, 3.02 (2.36, 3.87); both, 29.5 (19.7, 44.2). The LOS (median; IQR) was as follows: neither, 4 days (2; 9); hypotension only, 8 (4; 19); hypoxia only, 12 (5; 20); both, 13 (8; 18);  $p < 0.0001$ . The ICU LOS was as follows: neither, 2 days (1; 5); hypotension only, 4 (2; 13); hypoxia only, 9 (3; 14); both, 10 (4; 16);  $p < 0.0001$ . Charges were as follows: neither, \$50,370 (27,645; 110,480); hypotension only, \$125,558 (54,695; 306,506); hypoxia only, \$171,831 (65,179; 285,103); both, \$182,659 (59,749; 369,332);  $p < 0.0001$ . Patients with hypotension and/or hypoxia were much more likely to be discharged to rehabilitation/long-term care than those who had neither (aOR = 1.90; 95% CI 1.56, 2.32). **Conclusion.** In this statewide, multisystem analysis, prehospital hypotension/hypoxia had a profound impact on mortality, even after controlling for injury severity, age, and prehospital intubation. Hypotensive/hypoxic patients also had much higher LOS, ICU LOS, and inpatient charges and were much more likely to be discharged to long-term care. Implementation of the EMS TBI treatment guidelines targeting these issues is likely to have a major impact on outcomes.

#### 15. EVALUATION OF END-TIDAL CARBON DIOXIDE LEVELS BEFORE, DURING, AND AFTER RETURN OF SPONTANEOUS CIRCULATION IN OUT-OF-HOSPITAL CARDIAC ARREST

Ryan Murphy, Daniel Spaite, Uwe Stolz, Gary Smith, Annemarie Silver, Madalyn Karamooz, Margaret Mullins, John Tobin, Bentley Bobrow, *University of Arizona College of Medicine*

**Background.** In out-of-hospital cardiac arrest (OHCA), little is known about the changes in circulatory parameters that occur during the transition from ongoing cardiopulmonary resuscitation (CPR) to return of spontaneous circulation (ROSC). Previous work has shown good correlation between chest compression (CC) metrics (rate, depth, recoil, fraction) and end-tidal carbon dioxide (ETCO<sub>2</sub>) levels due to associated variations in blood flow. Thus, changes in ETCO<sub>2</sub> levels occurring around ROSC may be clinically important. **Methods.** Data from an Utstein-compliant registry along with electronic CC metrics and ETCO<sub>2</sub> data were collected by two emergency medical

services (EMS) agencies on consecutive intubated, adult, nontraumatic OHCA patients who achieved ROSC (October 8, 2008, to September 9, 2011). CC quality/event data were collected using accelerometer-equipped defibrillators (E Series, Zoll Medical). CC metrics and ETCO<sub>2</sub> data were compiled for each minute. ROSC was determined from patient care reports and defibrillator-verified CC cessation. Statistics: one-way analysis of variance, Kruskal-Wallis,  $\alpha = 0.05$ . **Results.** Twenty-eight cases of ROSC had available data (age  $64 \pm 16$  years, 64% male). Initial rhythm: ventricular fibrillation, 14; asystole, 8; and pulseless electrical activity, 6. Seven patients (25%) survived to discharge. The median ETCO<sub>2</sub> level increased gradually before ROSC ( $p = 0.02$ ; -4 minutes = 22.2 mmHg [interquartile range (IQR): 19.7–37.5], -3 minutes = 23.6 [16.9–37.7], -2 minutes = 33.5 [17.1–48.4], -1 minute = 36.2 [22.0–54.0]) to 43.3 mmHg in the minute of ROSC [30.3–99.0] and stayed relatively constant ( $p = 0.99$ ) after ROSC (+1 minute = 46.1 mmHg [30.0–64.0], +2 minutes = 41.6 [20.9–51.6], +3 minutes = 43.2 [15.6–48.4], +4 minutes = 42.6 [13.2–47.3]). There were no clinically relevant changes in CC or respiratory metrics preceding ROSC. A subset of patients with ETCO<sub>2</sub> <30 mmHg at ROSC ( $n = 4$ ) did not show increased ETCO<sub>2</sub> ( $p = 0.9$ ) in the minutes preceding ROSC (-4 minutes = 20.0 mmHg [19.7–20.2], -3 minutes = 20.6 [16.3–37.7], -2 minutes = 17.1 [7.9–35.9], -1 minute = 20.2 [10.6–27.7]), minute of ROSC = 17.9 mmHg [9.5–26.5]), and ETCO<sub>2</sub> stayed low even after EMS-declared ROSC (+1 minute = 20.6 [14.2–22.2], +2 minutes = 20.7 [13.1–23.2], +3 minutes = 15.6 [15.1–24.1], +4 minutes = 13.2 [13.2–13.2];  $p = 0.97$ ). In this low-ETCO<sub>2</sub> cohort, three of four patients (75%) experienced rearrest within 2.5 minutes of ROSC, whereas only one of 24 (4%) with ETCO<sub>2</sub> >30 mmHg experienced rearrest within 2.5 minutes. **Conclusion.** Prior to ROSC, the ETCO<sub>2</sub> level increases significantly. Thus, consistent ETCO<sub>2</sub> increases during resuscitation may herald impending ROSC and warrant heightened attentiveness by EMS providers. In this preliminary study, ETCO<sub>2</sub> level >30 mmHg was associated with longer sustained ROSC. Future study should evaluate whether it is appropriate to continue CPR in ROSC patients with low ETCO<sub>2</sub> level, since flow may be minimal and the risk of immediate rearrest may be very high.

#### 16. TRANSFER OF NONURGENT EMERGENCY MEDICAL SERVICES 9-1-1 CALLERS TO A TELEPHONE NURSE ASSESSMENT SERVICE (TNAS)

Ian Blanchard, Greg Vogelaar, Lois Andruski, Lara Osterreicher, Jane Huang, Jim Trumble, Wadhah Almansoori, Tyler Williamson, Andrew Anton, Alberta Health Services EMS and the University of Calgary

**Background.** Emergency medical services (EMS) systems have been challenged to maintain present service levels by factors such as offload delay and increasing call volumes. Some EMS systems have tried to leverage existing health care programs by transferring nonurgent EMS 9-1-1 callers to a telephone nurse assessment service (TNAS) instead of EMS response. **Objective.** To assess the potential impact to the quality of patient care of transferring low-priority 9-1-1 callers to a TNAS instead of EMS response. **Methods.** Prospective modified single-subject design on a sample of adult 9-1-1 callers in an urban center who received an Alpha or Omega response as determined by the Medical Priority Dispatch System (MPDS). These patients received routine EMS response, but were also

transferred to a TNAS for assessment prior to EMS arrival; the TNAS did not provide advice to the patient. The actual disposition from the EMS system was compared with the theoretical disposition from the TNAS. Impact to the quality of care if EMS treatment had not been provided was assessed by modified nominal group technique to achieve expert panel consensus. **Results.** A total of 405 patients met the inclusion criteria, the median age was 61 years (interquartile range 39, 79), and 56% were female. The TNAS identified that 98 patients (24%; 95% confidence interval [CI] 20%, 28%) required immediate EMS response, 137 patients (34%; 95% CI 29%, 39%) did not require EMS but were advised to visit the emergency department (ED), and 170 patients (42%; 95% CI 37%, 47%) required neither immediate EMS response nor an ED visit. The expert panel reviewed the group of 170 patients and concluded that in 14 (8%) cases, EMS treatment may have impacted mortality ( $n = 1$ ) or morbidity ( $n = 13$ ), and in 61 (36%) cases, it may have impacted comfort. Quality assurance review of the 14 mortality/morbidity cases revealed nine cases of errors in the MPDS/TNAS assessments and six cases of additional patient information/condition changes during EMS assessment. **Conclusion.** In this sample of low-priority 9-1-1 callers, transfer to a TNAS instead of EMS response may impact the quality of patient care by introducing a patient safety risk and the potential for delayed comfort measures. Further research determining who can be safely transferred to a TNAS and how to identify these patients is required.

#### 17. VOLUME SHIFTS SIGNIFICANTLY IMPACT CHEST COMPRESSION-GENERATED BLOOD FLOW

Joshua Lampe, Josiah Garcia, Tai Yin, George Bratinov, Christopher Kaufman, Lance Becker, University of Pennsylvania

**Background.** The existence of a blood volume shift during resuscitation has been a hypothetical explanation of the observed reduction in chest compression (CC) efficacy as a function of time. However, central blood flows, and therefore volumes, have not been thoroughly investigated during prolonged cardiopulmonary resuscitation (CPR). **Methods.** CPR hemodynamics in nine domestic swine (~30 kg) were studied using standard physiologic monitoring. Flow and pressure sensors were placed on the abdominal aorta (AA) and the inferior vena cava (IVC) slightly inferior to the kidneys. Ventricular fibrillation (VF) was electrically induced. Mechanical CCs were started after 10 minutes of untreated VF and continued for 54 minutes. **Results.** Hemodynamic data indicate that the study animals separated into two groups depending on the direction of the final net IVC flow. At the start of mechanical CC, there were no significant differences in IVC and AA flows between the two groups. At the end of resuscitation, the IVC and AA flows were significantly different between animals, with net forward IVC flow (IVCpos;  $49.9 \pm 13.9$  mL/min) and net negative IVC flow (IVCneg;  $-51.14 \pm 22.4$  mL/min). Surprisingly, the IVCneg animals had higher forward AA flows ( $8.0 \pm 2.0$  mL/min vs.  $-2.1 \pm 1.8$ ,  $p = 0.006$ ). As a result, the IVCneg animals were adding blood volume to the tissue below the flow probes, whereas the IVCpos animals were removing blood volume from the tissue below the flow probes at the end of resuscitation. **Conclusions.** Both the IVCneg and the IVCpos groups experienced significant volume shifts during the resuscitation. However, the volume shifts appear to be in opposite directions. The volume shifts between these reservoirs have a profound impact on the distribu-

tion of CC-generated blood flow. These observations require further investigation into the hemodynamics of volume shifts during resuscitation.

#### 18. DOES HEALTH STATUS INFLUENCE THE WILLINGNESS TO PROVIDE INFORMED CONSENT? RESULTS FROM A CARDIAC ARREST TRIAL CONDUCTED UNDER WAIVER OF INFORMED CONSENT

Ralph Frascone, Joshua Salzman, Demetris Yannopoulos, Brian Mahoney, Robert Swor, Robert Domeier, Marvin Wayne, Tom Aufderheide, Michael Olinger, Sandi Wewerka, David Tupper, Richard Holcomb, Regions Hospital EMS

**Background.** In a recent out-of-hospital cardiac arrest (OHCA) trial conducted under an initial waiver of informed consent (IC) (21 § CFR 50.24), data from public records were collected that shed light on whether the willingness to provide subsequent IC was associated with study outcomes. We hypothesized that IC was less likely to be obtained in subjects with significantly compromised health status. **Methods.** A post hoc analysis was conducted using data from a National Institutes of Health-funded randomized, controlled OHCA clinical trial comparing active compression-decompression cardiopulmonary resuscitation (CPR) plus an impedance threshold device (ACD+ITD) with standard CPR. The primary end point was survival to hospital discharge (HD) with favorable neurologic function [Modified Rankin Scale score (MRS)  $\leq 3$ ]. The status of the consent process was tabulated for all subjects who survived to hospital admission. Unadjusted Fisher's exact test and associated odds ratios were used to compare the MRS at HD by IC status. **Results.** Among a total study population of 1,655 subjects, 457 survivors were admitted to the hospital, and 440 had known HD status: 320 gave IC, 46 were unable to complete the IC process (the institutional review board allowed medical record review), and 74 denied IC. Survival with an MRS  $\leq 3$  was significantly higher in subjects where IC was given: 35.0% vs. 4.1%,  $p < 0.001$ . Sixteen of the 17 cases with missing MRS outcomes were in the IC-denial group. Even if all were considered to have favorable outcomes, the resulting rate (21.1%) was less than that seen among the subjects with IC given ( $p = 0.015$ ). **Conclusion.** The subjects who denied IC were significantly less likely to have favorable outcomes. These findings suggest that some resuscitation trials may unknowingly underrepresent those subjects with the worst prognoses in a target study population despite prespecified inclusion and exclusion criteria, because of the unwillingness or inability of the subjects or their families to provide IC.

#### 19. CORRELATIONS BETWEEN CPR QUALITY METRICS AND END-TIDAL CO<sub>2</sub> IN OUT-OF-HOSPITAL CARDIAC ARREST

Daniel Spaite, Uwe Stolz, Ryan Murphy, Madalyn Karamooz, Annemarie Silver, John Tobin, Terry Mullins, Gordon Ewy, Bentley Bobrow, Arizona Emergency Medicine Research Center

**Background.** Limited data from human cardiopulmonary resuscitation (CPR) studies indicate a possible relationship between chest compression (CC) quality metrics and end-tidal carbon dioxide (ETCO<sub>2</sub>) levels due to associated variations in blood flow. We evaluated the correlations between CC metrics and ETCO<sub>2</sub> during out-of-hospital cardiac arrest (OHCA). **Methods.** Data from an Utstein-compliant registry along with electronic CC metrics and ETCO<sub>2</sub> data were collected on consecutive

intubated, adult, nontraumatic OHCA patients treated by two emergency medical services agencies (September 2008 to September 2010). CC quality/event data were collected using accelerometer-equipped defibrillators (E Series, Zoll Medical) and were reviewed using Code Review software. CC metrics (rate, depth, recoil, fraction) and mean ETCO<sub>2</sub> data were compiled for each minute (first minute excluded because of artificially high values) when patients had no spontaneous circulation (absence of documented return of spontaneous circulation [ROSC] or ETCO<sub>2</sub> >50 mmHg). Multivariable regression was used to quantify the correlations between CC quality metrics and ETCO<sub>2</sub>. **Results.** Among 586 OHCA patients, 416 had defibrillator files, of which 123 were intubated patients with ETCO<sub>2</sub> data during CPR (study population). One hundred forty-two (34%) patients were not intubated; 112 (27%) were intubated but had no capnography data; 39 (9%) were intubated but had insufficient ETCO<sub>2</sub> data or ETCO<sub>2</sub> only after ROSC. Mean CC depth, mean CC release velocity ("recoil"), and CC fraction were each significantly related to ETCO<sub>2</sub> in univariate analysis ( $r^2 = 0.11, 0.09, 0.05$ , respectively,  $p < 0.05$ ), while CC rate and length of preshock/postshock pause were not. Ventilation rate was inversely related to ETCO<sub>2</sub> ( $r^2 = 0.10, -0.80$  mmHg/breath/min [95% confidence interval: -1.23, -0.37],  $p < 0.001$ ) and CC depth and recoil were significantly related to ETCO<sub>2</sub> in multivariable analysis (controlling for bystander CPR and ventilation rate). Adjusted coefficients were as follows: CC depth: 7.46 mmHg/inch (3.16, 11.76); recoil: 13.7 mmHg/500 milli-inches/sec (5.8, 21.7). **Conclusion.** The ETCO<sub>2</sub> level is significantly correlated with several CC metrics during CPR and might provide a meaningful measure of blood flow generated by compressions. Intraresuscitation evaluation of ETCO<sub>2</sub> levels may be helpful in improving blood flow and holds promise for impacting outcomes.

## 20. A PILOT STUDY EVALUATING THE USE OF DOUBLE-SEQUENTIAL EXTERNAL DEFIBRILLATION IN OUT-OF-HOSPITAL REFRACTORY VENTRICULAR FIBRILLATION

**Brent Myers, Jose Cabanas, Valerie De Maio, Ryan Lewis, Joseph Zalkin, WakeMed Health & Hospitals**

**Background.** Ventricular fibrillation (VF) is considered the out-of-hospital cardiac arrest (OOHCA) rhythm with the highest likelihood of neurologically intact survival. Unfortunately, there are occasions where VF does not respond to standard defibrillatory shocks. Current American Heart Association guidelines acknowledge there are insufficient data to determine the optimal pad placement, waveform, or energy level that produces the best conversion rates from OOHCA with VF. The objective of this study was to describe a technique of double-sequential external defibrillation (DSED) for cases of refractory VF during OOHCA resuscitation. **Methods.** A retrospective case series was performed in an urban/suburban emergency medical services (EMS) system with advanced life support care (population 900,000). Included were adult patients with OOHCA having refractory VF during resuscitation efforts by EMS providers. Refractory VF was defined as persistent VF following at least five unsuccessful single shocks with anterior-lateral pad placement and a dose of antiarrhythmic medication without change. Once in refractory VF, EMS personnel applied pads with an anterior-posterior pad placement and utilized a second defibrillator to attempt single defibrillation with the new monitor/pad

placement. If VF continued, the EMS personnel then utilized the original and second monitor/defibrillator (two sets of pads with two monitors) charged to maximum energy, and shocks were delivered from both machines at the same time. Data were collected from electronic dispatch and patient care reports for descriptive analysis. **Results.** From January 7, 2008, to December 31, 2010, a total of 10 patients were treated with DSED. The median age was 76.5 years (interquartile range [IQR]: 65–82), with a median resuscitation time of 51 minutes (IQR: 45–62). The median number of single shocks was 6.5 (IQR: 6–11), with a median of 2 (IQR: 1–3) DSED shocks delivered. VF broke after DSED in seven cases (70%). Only three patients (30%) had return of spontaneous circulation in the field and none survived to discharge. There were no adverse events or cardiac monitor failures reported. **Conclusion.** This pilot study demonstrates that the DSED technique is feasible in the out-of-hospital setting. In this series, refractory VF was terminated 70% of the time, but no patient survived to discharge. Further research is needed to better understand the characteristics and treatment strategies of refractory VF.

## 21. AN EPIDEMIOLOGIC PROFILE OF RESUSCITATION SYSTEMS-OF-CARE PERFORMANCE IN OUT-OF-HOSPITAL CARDIAC ARREST

**Zach Dewar, Andrew Travers, Jan Jensen, Alix Carter, Emergency Health Services, Nova Scotia/Dalhousie University**

**Background.** The study objective was to link structure, process, system, and outcome (SPSO) resuscitation measures from community, emergency medical services (EMS), and in-hospital systems of care (SOCs), to identify factors significantly associated with positive outcomes by examining the system as a whole. **Methods.** In a provincial EMS system responding to 920,000 residents, SPSO data were collected from first-responder charts, EMS dispatch, electronic patient care records, and hospital charts for all 2011 out-of-hospital cardiac arrests (OOHCAs). Data were linked using deterministic linkage. Descriptive and chi-square analyses were performed on cases of Utstein-defined cardiac etiology. The primary outcome was survival to discharge. The secondary outcome was EMS performance, measured by sustained return of spontaneous circulation (ROSC) on emergency department (ED) arrival. Factors for analysis were determined a priori by consensus, grounded in literature. Significance adjusted to  $p < 0.01$  for multiple comparisons. **Results.** EMS responded to 1,514 cases of possible OOHCA in 2011. Excluded cases included: 189 (12.5%) overtriage, no patient, missing data, duplicate entries, in-hospital cases, and interfacility transfers; 68 (4.5%) traumatic OOHCA; 714 (47%) no attempted resuscitation; and 27 (1.8%) Utstein noncardiac etiology. Five hundred sixteen of 1,514 (34%) cardiac etiology cases were analyzed. No unlinked records were present. The mean age was 66 years (standard deviation = 17.5), and 353 were male (68.4%). In 222 of 516 (43%) cases, resuscitation was terminated in the field; 294 of 516 patients (57%) were transported; 122 of 516 patients (23.6%) had sustained ROSC; 36 of 122 patients (29.5%) received ED targeted therapeutic hypothermia (ED TTH); 24 of 122 patients (19.7%) were transferred to higher-level care; and 32 of 122 patients (26.2%) had percutaneous coronary interventions (PCIs). Of patients with sustained ROSC, 42 of 122 (34.4%) survived to discharge with a median cerebral performance category of 1 (90th percentile: 2). Forty-two of 516

(8.1%) survived to discharge. Factors significantly associated with survival included witnessed OOHCA ( $p = 0.005$ ), first-responder CPR ( $p = 0.008$ ), epinephrine ( $p < 0.001$ ), intubation ( $p = 0.001$ ), sustained ROSC ( $p < 0.001$ ), ED TTH ( $p < 0.001$ ), transfer to higher-level care ( $p < 0.001$ ), and PCI ( $p < 0.001$ ). Limitations include collection from administrative databases, limited first-responder data, and limited availability of postarrest measures. **Conclusions.** Factors from each SOC were associated with survival. These findings have implications for prospective research, clinical practice, and policy to integrate SOCs to improve OOHCA outcomes.

## 22. DETERMINANTS OF VENTRICULAR FIBRILLATION INCIDENCE AS FIRST-RECORDED RHYTHM DURING OUT-OF-HOSPITAL CARDIAC ARREST AND ASSOCIATION WITH LONG-TERM NEUROLOGIC OUTCOMES

**Demetris Yannopoulos, Richard Holcomb, Ralph Frascone, Brian Mahoney, Marvin Wayne, Robert Swor, Robert Domeier, Michael Olinger, David Tupper, Tom Aufderheide, University of Minnesota Medical Center**

**Background.** We sought to identify the factors that were associated with higher incidence of ventricular fibrillation and survival with good neurologic function in the ResQTrial, which compared standard cardiopulmonary resuscitation (S-CPR) versus active compression-decompression CPR with an inspiratory impedance threshold device (ACD+ITD) in patients with out-of-hospital cardiac arrest (OHCA). **Methods.** A retrospective analysis of a randomized multicenter clinical study of 1,655 patients with OHCA. 88.3% (106/120) of the patients discharged with good neurologic function (modified Rankin score [MRS]  $\leq 3$ ) had a first recorded rhythm of ventricular fibrillation/pulseless ventricular tachycardia (VF). The first rhythm was recorded in 99.4% (1,645/1,655) of the cases about 9.5 minutes after the 9-1-1 call, on average 3 minutes after the arrival of EMS on the scene and after CPR was performed for at least 2 minutes. **Results.** A total of 32.8% of the patients had VF as the presenting rhythm and 42.8% received bystander CPR. The presence of bystander CPR was associated with a higher VF incidence only in the S-CPR group (40.8% versus 23.1% with no bystander,  $p = 0.001$ ), but survival was 7.6% versus 4.6%,  $p = 0.09$ . Presence or absence of bystander CPR led to similar VF incidence and survival in the ACD+ITD group: 36.1% versus 33.9% and 9.0% versus 8.9%, respectively,  $p > 0.2$ . After propensity adjustment for witnessed arrest, age <67 years, gender, and public location, bystander CPR lost significance. In the absence of bystander CPR, ACD+ITD significantly increased the incidence of first-recorded VF compared with S-CPR from 106 of 459 patients (23.1%) to 164 of 484 patients (33.9%) (odds ratio [OR] 1.71, 95% confidence interval [CI] 1.27, 2.30,  $p < 0.001$ ), and in patients with VF, return of spontaneous circulation increased from 65 of 459 patients (14.2%) to 104 of 484 patients (21.5%) (OR 1.66, 95% CI 1.16, 2.37,  $p = 0.004$ ), leading to an overall doubling of survival with MRS  $\leq 3$  from 21 of 455 patients (4.6%) to 43 of 482 patients (8.9%) (OR 2.02, 95% CI 1.15, 3.65,  $p = 0.009$ ). After propensity adjustment, ACD+ITD remained a significant predictor of an MRS  $\leq 3$  ( $p = 0.02$ ). **Conclusions.** VF was the most important predictor of survival with MRS  $\leq 3$ . In the absence of bystander CPR, ACD+ITD increased VF incidence as the first-recorded rhythm and doubled survival to hospital discharge with MRS  $\leq 3$  compared with S-CPR.

### 23. CAN PARAMEDICS DIAGNOSE SEPSIS IN THE PREHOSPITAL SETTING?: A FEASIBILITY STUDY

Andrew Travers, Robert Green, Ed Cain, Samuel Campbell, Jan Jensen, David Petrie, Dalhousie University

**Background.** Evidence demonstrates that sepsis patients presenting to emergency departments (EDs) benefit from early goal-directed therapy (EGDT). Accurate paramedic diagnosis is important to initiate EGDT promptly. The objective was to evaluate diagnostic performance of sepsis by paramedics, compared with emergency physician (EP) diagnosis. **Methods.** This prospective, observational study was of a convenience sample of adult patients transported to a tertiary ED by paramedics. Patients were enrolled if dispatched as: abdominal pain, breathing problems, sick person, unknown problem, unconscious/fainting, chest pain, or any case in which paramedics considered sepsis a possible diagnosis. Patients were not enrolled if they were interfacility transfers or had cardiac arrest, electrical shock, or trauma. Paramedic diagnoses of sepsis were entered into study data-collection forms, which were compared with blind, independent documentation of admission diagnosis by attending EPs (considered the "gold standard"). For missing EP forms, ED chart review was conducted. Specificity, sensitivity, accuracy, positive and negative predictive values, and ratios were calculated with 95% confidence intervals (CIs). **Results.** Nine hundred fifty-six patients were enrolled by paramedics between January and September 2008. Three hundred twenty-seven of 956 (34.2%) were excluded for the following reasons: no paramedic diagnosis recorded (249/956, 26.0%), no EP diagnosis available (73/956, 7.6%), or patient left the ED without being seen/no EP diagnosis was made (5/956, 0.5%). The paramedic and EP diagnoses were available for 629 of 956 patients (65.8%), and were included in the final analysis. Paramedics identified 170 of 629 (27.0%) patients as septic, and EPs identified 71 of 629 (11.3%). The sensitivity and specificity of paramedic sepsis diagnosis were 73.24% (95% CI 61.40–83.05) and 78.85% (95% CI 75.23–82.17), respectively. The accuracy was 78% (492/629, 52 true positive, 440 true negative). The positive and negative predictive values were 30.59% (95% CI 23.76–38.11) and 95.86% (95% CI 93.61–97.49), respectively. The positive likelihood ratio was 3.46 (95% CI 2.80–4.29), and the negative likelihood ratio was 0.34 (95% CI 0.23–0.50). Study limitations included lack of prehospital use of thermometers or point-of-source lactate testing and large proportion of incomplete EP forms, requiring retrospective chart review. **Conclusion.** Paramedic diagnosis of sepsis has greater specificity than sensitivity, with reasonable accuracy between paramedics and EPs. Further research should evaluate thermometry and point-of-care lactate testing diagnostic tools, derivation of a clinical prediction rule, and EGDT delivery in the prehospital setting.

### 24. EVALUATION OF A PREHOSPITAL SEPSIS PROTOCOL

Jennifer Walker, Henderson McGinnis, Michael Halsey, Brian Hiestand, Wake Forest Baptist Medical Center

**Background.** Multiple studies show improved outcomes with early goal-directed therapy in sepsis; however, most literature involves initiation of therapy in hospital. The purpose of this study was to evaluate prehospital provider recognition of sepsis and the impact on treatment and patient outcomes. **Methods.** We performed a retrospective analysis of a critical care transport database involving all

adult interfacility transfers to a tertiary care center between September 2010 and November 2011. We included patients who had suspected infection plus two or more systemic inflammatory response syndrome (SIRS) criteria (temperature <36°C or >38°C, heart rate >90 beats/min, respiratory rate >20 breaths/min or partial pressure of carbon dioxide [PaCO<sub>2</sub>] <32 mmHg, white blood cell [WBC] count <4,000 or >12,000); patients with clear noninfectious diagnoses were excluded. Fisher's exact test and the Wilcoxon rank sum test were used to compare categorical and continuous data, respectively. **Results.** Of 717 patients transported during that time, 214 patients (29.8%) met the definition of sepsis. Of these, 106 (49.5%) were male, 185 (86%) were white, and the mean age was 57.6 years. Sepsis was documented by the transport team in 59 cases (28%, 95% confidence interval [CI] 22–34%). Multivariate logistic regression models were prepared to determine covariates that affected sepsis recognition. In the final model, the only significant factors affecting the ability to recognize sepsis were the initial blood pressure (odds ratio [OR] 0.98, 95% CI 0.97–0.99) and the initiation of vasopressors or inotropes at the outside hospital (OR 4.7, 95% CI 2.2–10.3). Mean arterial pressure, heart rate, and systolic blood pressure improved during transport of both unrecognized and recognized septic patients; documented recognition of sepsis did not make a significant difference in vital signs ( $p = 0.29$ ,  $p = 0.19$ , and  $p = 0.14$ , respectively). If sepsis was recognized, however, providers gave more fluid ( $p < 0.001$ ), were more likely to start pressors ( $p < 0.001$ ), and were less likely to turn off pressors started by the outside hospital ( $p = 0.017$ ). **Discussion:** Underrecognition of sepsis is present in this cohort. More aggressive interventions occurred when sepsis was recognized; however, patient vital signs improved regardless of sepsis recognition. This may be confounded because of the retrospective nature of this analysis and the absence of a true control group for comparison. **Conclusion.** Patients with suspected sepsis generally improve during interfacility transport in a system with a defined sepsis protocol, regardless of whether sepsis was explicitly recognized by the providers.

### 25. BARRIERS TO IMPLEMENTATION OF RECOMMENDATIONS FOR TRANSPORT OF CHILDREN IN GROUND AMBULANCES

Rashida Woods, Cara Doughty, Anthony Gilchrest, Manish Shah, Rainbow Babies and Children's Hospital

**Background.** Because of the risk of secondary injury in the event of an ambulance collision, the National Highway Traffic Safety Administration (NHTSA) released draft recommendations in 2010 to define guidelines for safe transport of children in ground ambulances. Lack of awareness and other barriers may limit emergency medical services (EMS) agencies from fully implementing these recommendations. The purpose of this study was to assess awareness of the NHTSA guidelines among EMS agencies in Texas and identify potential barriers in complying with them. **Methods.** This was a cross-sectional, online survey of a sample of 9-1-1-responding ground transport EMS agencies in Texas. Using case-based scenarios, the survey assessed each agency's current transport methods with respect to the five situations defined in the NHTSA guidelines. It also assessed each agency's plans and potential barriers to implementation. Descriptive data reporting was utilized. **Results.** Of the 160 EMS agencies contacted, 56 (35%) met the inclusion criteria and completed the survey. Only 36% were aware that NHTSA issued the guidelines.

Agencies utilize ideal or acceptable transport modalities 75% of the time when medical monitoring and/or interventions are required, and 69% of the time when spinal immobilization is required. For children who are uninjured or not ill, 93% of agencies use a mode of transport that is not recommended by NHTSA. Also, 53% of agencies transport ill and/or injured children who do not require monitoring and/or intervention via a method that is not recommended by NHTSA. Finally, 56% of agencies use inappropriate methods when transporting children who are part of a multiple patient transport. All of the agencies reported necessary changes to implement the recommendations, the most common of which were provision of provider education (75%) and the purchase of new equipment (52%). In addition, 61% were unsure about the availability or did not have the financial means to implement the recommendations. **Conclusion.** Few EMS agencies are aware of the draft NHTSA guidelines on safe transport of children in ground ambulances, and many agencies do not currently utilize acceptable transport methods. In addition to knowledge, cost of education and equipment purchase may prohibit implementation.

### 26. EMS STRETCHER "MISADVENTURES" IN A LARGE, URBAN EMS SYSTEM: A LONGITUDINAL ANALYSIS OF CONTRIBUTING FACTORS AND RESULTANT INJURIES

Tyler Kallsen, Annette Arthur, Stephen Thomas, Jeffrey Goodloe, University of Oklahoma Health Science Center

**Background.** Earlier analysis in this large, urban emergency medical services (EMS) system described EMS stretcher "misadventure" contributing factors and associated injuries. There continues to be paucity of data regarding this important aspect of safety for patient and EMS professional alike. This longitudinal study's purpose was to continue to describe and analyze characteristics associated with undesirable stretcher operations, with or without resultant injury to patients and/or EMS professionals in a large, urban EMS agency. **Methods.** In the EMS agency studied, all stretcher-related misadventures are required to be documented by EMS personnel, regardless of whether injury results, using free-text incident-reporting software. All such stretcher-related reports for incidents that occurred between July 1, 2009, and June 30, 2012, were queried from the agency's risk-management database for retrospective analysis, avoiding the Hawthorne effect in stretcher operations. **Results.** During the three years studied, the EMS agency transported 404,178 patients. Fifty-nine stretcher incidents were reported (0.15 per 1,000 transports). No substantive patient injury occurred. Eight EMS providers sustained minor injuries, including five back injuries, two knee injuries, and two arm contusions. There were three primary times of stretcher operation problems: unloading, loading, and surface movement. Forty-one of 59 incidents (69.5%) occurred during unloading; five of 59 (8.5%) occurred during loading; and 13 of 59 (22.0%) occurred during surface movement. There were five predominant contributing aspects to stretcher operation problems, with some incidents stemming from multiple aspects: stretcher-ambulance safety latch mechanism, ground surface conditions, equipment failure, bariatric patient size, and combative patient behavior. Nineteen of 59 (32.2%) related to the stretcher's not engaging locking mechanisms on the ambulance floor; 13 of 59 (22.0%) related to poor ground surface conditions; five of 59 (8.5%) related to equipment malfunction; three of 59 (5.1%) related to patient weight exceeding 450 lb, compounded by patient movement on the stretcher; and two

of 59 (3.4%) related to combative patient movement. There was no association between cause and crew injury, Fisher's exact test = 0.087. **Conclusions.** In a large, urban EMS system, the incidence of injury related to stretcher operations is markedly low, with few personnel injuries and no substantive patient injuries incurred during the three-year study period. EMS personnel should be particularly aware of increased risk for stretcher misadventure during patient unloading.

#### 27. HEAD-TO-HEAD COMPARISON OF DISASTER TRIAGE METHODS IN PEDIATRIC, ADULT, AND GERIATRIC PATIENTS

Keith Cross, Mark Cicero, University of Louisville

**Background.** A variety of methods have been proposed and used in disaster triage situations, but there is little more than expert opinion behind most of them. Anecdotal disaster experiences have often reported mediocre real-world triage accuracy. **Objective.** To evaluate the comparative accuracy of several disaster triage methods for predicting mortality in a large number of trauma patients. **Methods.** Pediatric, adult, and geriatric trauma victims from the National Trauma Data Bank were assigned triage levels using each of six disaster triage methods: simple triage and rapid treatment (START); Fire Department of New York (FDNY); CareFlight; Glasgow Coma Scale (GCS); Sacco Score; and Unadjusted Sacco Score. Triage assignments were compared against patient mortality at hospital discharge using area under the receiver-operating curve (AUC). Secondary outcomes included death on arrival, use of a ventilator, and lengths of stay. Sensitivity analysis assessed triage accuracy in patients by age, trauma type, and gender. **Results.** 530,583 records were included in this study. The Sacco Score predicted mortality most accurately, with AUC of 0.883 (95% confidence interval [CI]: 0.880–0.885), and performed well in most subgroups. The FDNY criteria were more accurate than START for adults, but less accurate for children. CareFlight did best in burn victims, with an AUC of 0.87 (95% CI: 0.85–0.89), but misclassified more salvageable trauma patients to "Dead/Black" (41% survived) than did other disaster triage methods (~10% survived). **Conclusions.** Among six disaster triage methods compared against actual outcomes in trauma registry patients, the Sacco Score predicted mortality most accurately. This analysis highlighted the comparative strengths and weakness of START, FDNY, CareFlight, and Sacco, suggesting areas in which each might be improved. The GCS predicted outcomes similarly to dedicated disaster triage strategies.

#### 28. MASS-GATHERING MEDICINE: FACTORS PREDICTING PATIENT PRESENTATION

Samuel Locoh-Donou, Yan Guofen, Melanie Welcher, Thomas Berry, William Brady, University of Virginia

**Background.** This study was conducted to identify the event characteristics predicting patient presentation rates at all mass gatherings held at or near a Southeastern U.S. university. **Methods.** We conducted a retrospective review of all EMS records from mass-gathering patient presentations between October 24, 2009, and August 27, 2011. All patrons seen by EMS were included. Event characteristics included crowd size, venue percentage seating, venue location (inside vs. outside), venue boundaries (bounded vs. unbounded), presence of free water, presence of alcohol, average heat index, presence of climate control, and event category (football, concerts, public exhibitions, nonfootball athletic events). We identified 79

mass-gathering events, for a total of 670 patient presentations. The cumulative patron attendance was 917,307. The patient presentation rate (PPR) for each event was calculated as the number of patient presentations per 10,000 patrons in attendance. A Poisson logistic regression model analysis was used to link this rate to the event characteristics while controlling for crowd size. **Results.** Univariate logistic regression analysis making use of rate ratios (RRs) revealed that increased rates were strongly associated with outside venues (RR = 3.002,  $p = 0.000$ ), absence of free water (RR = 1.663,  $p = 0.048$ ), absence of climate control (RR = 0.330,  $p = 0.000$ ), and a high heat index (RR = 1.211,  $p = 0.003$ ). For every 10-unit increase in the heat index, the PPR increased by 21%, and the presence of climate control resulted in a 67% decrease in the PPR. The presence of alcohol was not found to significantly affect the PPR. Football events were found to have the highest PPR, followed sequentially by public exhibitions, concerts, and nonfootball athletic events. Models including event characteristics as covariates were subsequently developed to jointly predict the rates of medical events. **Conclusion.** Among the predictors studied, several were found to be strongly associated with the rate of patient presentations. These findings should be considered during the process of EMS resource planning for future mass gatherings.

#### 29. PARAMEDIC WORK SAMPLING FOR THE ASSESSMENT OF PARAMEDIC TRAINEES: A RELIABILITY, VALIDITY, AND FEASIBILITY STUDY

Walter Tavares, Justin Mausz, Victor Sun, University of Toronto

**Background.** Maintaining patient safety in prehospital settings involves ensuring that paramedics are indeed competent. Workplace-based assessments (WBAs) are challenging; however, they have the advantage of authenticity and the potential for optimal construct validity if sampled appropriately. The purpose of this study was to establish the reliability, validity, and feasibility of a WBA that involved sampling trainee performance in an emergency medical services (EMS) context for entry-to-practice decisions. **Methods.** We used a prospective observational study design. Paramedic clinical sampling (PCS) followed an objective structured clinical examination (OSCE)-like structure by having trainees move through five different "stations" (i.e., raters and clinical cases) but in an EMS setting. Trainees responded to emergency calls and were required to demonstrate the technical and nontechnical skills expected of an entry-level paramedic from point of contact to transfer of care, for any patient interaction with which they happened to be presented. Reliability was determined using scores assigned by raters on a seven-dimension global rating scale. Content validity (evaluated by comparisons with EMS data) and convergent validity (evaluated by comparing PCS scores to OSCE scores) were used to inform construct validity. Feasibility was defined as rater satisfaction, compliance with the planned assessment process, and the absence of rater intervention. **Results.** Forty-nine trainees were assessed over three weeks using a PCS approach. The overall mean score for trainees was 5.39 (standard deviation  $\pm 0.48$ ). Reliability was calculated using generalizability theory and reached a  $g$ -coefficient of 0.49. Context specificity (i.e., variance attributable to cases) was the most significant threat to reliability. A D-study revealed that 17 cases would be needed to achieve a reliability ( $g$ -coefficient) of 0.76 or 13 cases for an interval of less than 1 point. Case variability was similar to the most common case types experienced by a large EMS. The disattenuated

correlation between this WBA and the OSCE was  $r = 0.73$  ( $p = 0.01$ ). Rater satisfaction with the process reached 72% with a 94% compliance rate. Raters needed to intervene in 12% of the trainee-led patient interactions. **Conclusions.** PCS has the potential to be psychometrically defensible and feasible, and therefore should be considered for the assessment of paramedic trainees at the entry-to-practice level.

#### 30. USE OF ONLINE MODULES IN TEACHING TOXICOLOGIC EMERGENCIES TO EMS PROVIDERS

Jordan Guffin, Jennifer Werner, Adam Tobias, Michele Dorfman, University of Pittsburgh

**Background.** Emergency medical services (EMS) providers are often the first contact with patients presenting with toxicologic emergencies. While life-threatening toxicologic emergencies are rare, their recognition and timely intervention are critical. The purpose of this intervention was to provide paramedics with Web-based continuing education on the management of toxicologic emergencies in the prehospital setting. **Methods.** Between June 1 and August 1, 2012, paramedics in Western Pennsylvania participated in an online module containing multiple toxicology case scenarios and knowledge acquisition and retention questions. Participants completed pre- and postmodule surveys to obtain feedback on the use of the online module as an educational tool and to assess knowledge acquisition regarding the toxicology topics. **Results.** Thirty-seven paramedics participated in this module, and 27 of them completed it. Of the paramedics who completed the module, survey, and test, the median age range and years of EMS experience were 31–40 years old and greater than 10 years, respectively. Twenty-seven participants (100%) had participated in online continuing education in the past. Following the program, 89% of the participants reported they would participate in a similar training program again, 74% reported enjoying learning on their own time via online education, and 67% reported that online education improved their EMS field performance. Only 15% felt that they had better knowledge retention with online learning. The knowledge acquisition questions overall were answered with 77% accuracy, compared with 59% prior to completing the module. **Conclusions.** Paramedics participating in this educational initiative enjoyed using online modules for continuing education of toxicology cases and felt it would improve their EMS field performance. Paramedics were able to demonstrate knowledge acquisition following participation in the module. Online modules are feasible tools for use in continuing education for EMS providers. It will be important to determine what barriers led to some participants' not completing the modules. Further study is needed to determine whether online modules offer the same level of knowledge retention over time when compared with traditional methods of education, and whether this type of training can be used as a form of remediation.

#### 31. EXPERIENTIAL AND RATIONAL CLINICAL DECISION MAKING: A SURVEY TO DETERMINE DECISION-MAKING STYLES OF PARAMEDICS

Jan Jensen, Lisa Calder, Mark Walker, Andrew Travers, Walter Tavares, Asha Bienkowski, Pat Croskerry, Dalhousie University Division of EMS

**Background.** Two major processes underlie human decision making: experiential ("intuition") and rational (conscious and deliberate). The predominant process that paramedics use for making clinical decisions is unknown. The objective of this study was to determine paramedics' preferences toward and perceived

ability to use experiential and rational thinking. **Methods.** Paramedics employed in a provincial ground ambulance system voluntarily completed a paper survey during 2012 professional development sessions. The survey included eight demographic questions and the Rational Experiential Inventory-40, a 40-question validated psychometric tool, scored on a five-point Likert scale. The tool has 20 questions on each thinking style, of which 10 assess favorability and 10 assess ability to use that style. Analysis included descriptive statistics, and t-tests to determine differences in overall thinking style scores, favorability toward each style, and ability to use each style. Differences in thinking styles were evaluated within demographic variables with t-tests and analysis of variance (ANOVA). Significance was set at 0.05 for all tests, with corrections for ANOVA comparisons. **Results.** The response rate was 96.1% (904/941). Most participants were male ( $n = 628$ , 69.5%), primary or advanced care paramedics (PCPs,  $n = 502$ , 55.5%; ACPs,  $n = 294$ , 32.5%), the median age was 36 years (interquartile range [IQR] 29–42), and the median number of years of experience was 10 (IQR 4–16). The mean rational scores were higher than experiential: 3.86/5 (95% confidence interval [CI] 3.83–3.87) vs. 3.41/5 (95% CI 3.38–3.44),  $p < 0.001$ . The participants scored their ability to use rational thinking higher than experiential (3.93/5 [95% CI 3.90–3.96] vs. 3.60/5 [95% CI 3.58–3.63],  $p < 0.001$ ), and more favored rational than experiential (3.79/5 [95% CI 3.76–3.82] vs. 3.22/5 [95% CI 3.18–3.26],  $p < 0.001$ ). The only demographic subgroup in which a difference was found in experiential scores was gender, with males scoring higher than females: 3.67 vs. 3.51,  $p < 0.001$ . The following demographic subgroups scored rational questions higher: younger age ( $p < 0.001$ ), ACPs vs. PCPs (3.94/5 vs. 3.83/5,  $p = 0.05$ ), fewer years of working experience ( $p < 0.001$ ), and participants working in urban and mixed urban-rural areas versus rural areas ( $p = 0.001$ ). **Conclusion.** Paramedics perceive they have the ability to use and favor rational over experiential thinking. Future research includes determining differences in thinking styles of paramedics with work experience and students. This study adds to what is known on paramedic decision making, and is important for developing continuing education and clinical support tools.

### 32. EMERGENCY MEDICAL SERVICES EVALUATION OF FALLS IN ASSISTED LIVING FACILITIES: A RETROSPECTIVE COHORT STUDY AND CLINICAL PROTOCOL EVALUATION

**Michael Bachman, J. Myers, Jefferson Williams, Diane Miller, Benjamin Currie, Michael Lyons, Joseph Zalkin, Valerie De Maio, Holly Tibbo-Valeriotte, Johna Register-Mihalik, A. Jones, Alan Kronhaus, Wake County Department of Emergency Medical Services**

**Background.** Emergency medical services (EMS) often transports from assisted living facilities (ALFs) patients who suffer simple falls. An EMS protocol could avoid unnecessary transport for a subset of these patients, while ensuring that patients with time-sensitive conditions are transported. Our objective was to begin to derive an EMS protocol to determine which patients require transport. **Methods.** We conducted a retrospective cohort study of patients in our urban EMS system (population 900,000), in a subset of ALFs served by a specific primary care group, who were transported to the emergency department from July 2010 to June 2011 for a chief complaint of “fall.” The primary outcome was defined as “time-sensitive intervention”

(TSI) and was met by patients who had wound repair or fracture, admission to the intensive care unit, operating room, or cardiac catheterization laboratory, death during hospitalization, or readmission within 48 hours. A priori, an EMS protocol to require transport for patients needing TSI was derived by consensus between EMS and primary care. The protocol utilizes screening criteria including history and examination findings to recommend transport versus nontransport with close primary care follow-up. The EMS protocol was retrospectively applied to determine which patients required transport. Data were analyzed using standard descriptive statistics. **Results.** Of 653 patients transported across 30 facilities, 644 had sufficient data. Of these, 197 (31%) met the primary outcome. Most patients who required TSI had fracture (73) or wound repair (92). The EMS protocol identified 190, for a sensitivity of 96% (95% confidence interval [CI]: 93% to 98%), specificity of 46% (95% CI: 44% to 47%), and negative predictive value of 97% (95% CI: 93% to 99%). Of seven false negatives, three were readmitted (and discharged) for another fall, three had hip fractures that were repaired, and one had a lumbar compression fracture that was discharged. **Conclusions.** In this cohort, one-third of patients with falls in ALFs required TSI and therefore EMS transport. An EMS protocol may have sufficient sensitivity to safely allow for nontransport of a subset of patients with falls in ALFs. Prospective evaluation of this protocol is necessary to validate this hypothesis.

### 33. DEVELOPING A FUNCTIONAL “GOLD STANDARD” FOR MASS-CASUALTY TRIAGE

**E. Brooke Lerner, Courtney McKee, Charles Cady, David Cone, M. Riccardo Colella, Arthur Cooper, Phillip Coule, Julio Lairet, J. Marc Liu, Ronald Pirrallo, Scott Sasser, Richard Schwartz, Greene Shepherd, Raymond Swinton, Medical College of Wisconsin**

**Background.** Research on mass-casualty triage systems is inhibited because there is no functional “gold standard” available to calculate sensitivity and specificity. Until there is agreement on the types of patients who should be identified by each triage category, it is not possible to evaluate or compare the accuracy of the various triage systems being utilized. The objective of this study was to develop a consensus-based, functional gold-standard definition for each mass-casualty triage category. **Methods.** Experts were recruited through the lead investigators’ contacts and their suggested contacts. Key informant interviews were conducted to develop a list of potential criteria for each triage category. Participants were interviewed in order of their availability until redundancy of themes. Participants were blinded to each other’s responses during the interview. Based on the results of the interviews, a modified Delphi survey was developed and delivered to all recruited experts. In the first two rounds, the participants could add, remove, or modify criteria. In the final rounds, edits were made to the criteria until there was at least 80% agreement. **Results.** Thirteen national and local experts were recruited to participate in the project. A total of six interviews were conducted. Three rounds of voting were performed, with 12 respondents participating in the first round, 12 in the second round, and 13 in the third round. After the first two rounds, the criteria were modified according to respondent commentary. In the final round, over 90% agreement was achieved for all but one criterion. A single e-mail vote was conducted on edits to that criterion and consensus was achieved. An example of a final crite-

rión is “minimal” patients are those discharged from the emergency department with no x-rays or an extremity x-ray that was negative or showed an uncomplicated fracture; had no laboratory testing; received only simple wound repair (single-layer suturing only); and received no intravenous medications from emergency medical services or in the hospital. **Conclusion.** A consensus-based, functional gold-standard definition for each mass-casualty triage category has been developed. These gold-standard definitions can be used to evaluate the accuracy of mass-casualty triage categories after an actual incident or during training.

### 34. COMPARING TWO PREDICTION MODELS FOR MASS-GATHERING EVENTS

**Jose Nable, Asa Margolis, Benjamin Lawner, Alexander Perricone, Michael Millin, Samuel Galvagno, Debra Lee, Richard Alcorta, University of Maryland School of Medicine**

**Background.** Predicting medical resource usage by spectators at mass gatherings has historically been difficult. The literature describes at least two models to forecast the numbers of patients requesting medical assistance and those who require transport to an emergency department (ED). The objective of this study was to compare the ability of two models to accurately predict the number of patients evaluated and transported at a mass-gathering event. **Methods.** This retrospective analysis of the 2011 Baltimore Grand Prix (BGP) evaluated the ability of the Arbon and Hartman methods to predict the number of patient evaluations and patients requiring transport to an ED. In the Arbon method, several environmental features at the BGP, including crowd size, weather, and type of event, were input into an equation derived by regression modeling. The Hartman model utilized a scoring system based on weather, presence of alcohol, crowd size, and age and intention of the spectators to stratify the incident as a “minor,” “intermediate,” or “major” event, with predicted resource demand for each category. The actual number of patients evaluated and transported at the BGP were tabulated with an electronic patient tracker system, and compared with the numbers predicted by the Arbon and Hartman models. **Results.** For the day of the BGP with the largest crowd size (60,000), the Arbon method predicted a total of 64.4 patient evaluations with 2.2 requiring transport. The Hartman scoring system categorized the event as a “major” incident, with a mean predicted 71 evaluations and 5.5 needing transport. Actual patient data demonstrated a total of 52 evaluations with 4 transported. While the Arbon prediction had a variance of 24% from actual number of evaluations, the Hartman prediction was 37% greater than the true amount. The Arbon method for predicting transports was 45% less than actual, whereas the Hartman method predicted a value 38% greater than the actual number of transports. **Conclusions.** Both the Arbon and Hartman methods are better at predicting numbers of patient evaluations than transports. These observations call attention to the need to develop a versatile and accurate model to predict resources needed at mass-gathering events.

### 35. A TARGETED APPROACH TO COMMUNITY CONSULTATION FOR AN EXCEPTION FROM INFORMED CONSENT STUDY: MORE SUPPORT THAN WILLINGNESS TO PARTICIPATE

**Eugene Vu, Kathy Arnold, Tony Carnevale, Mohamad Daya, Denise Griffiths, Dana Zive, Aarzoo Sidhu, Terri Schmidt, OHSU Emergency Medicine**

**Background.** Community consultation (CC) is a key part of research conducted under

the Food and Drug Administration Exemption from Informed Consent (EFIC) framework. The best practices to achieve CC remain uncertain. We report results from a targeted approach that surveyed at-risk members of a health maintenance organization (HMO). **Methods.** The Resuscitation Outcomes Consortium (ROC) Amiodarone, Lidocaine, or Placebo Study (ALPS) is being conducted under EFIC. As part of the CC effort, we designed a survey with the Kaiser Permanente Northwest Center for Health Research. Surveys were mailed to 2,000 Kaiser members between the ages of 48 and 78 years residing in a three-county region served by participating emergency medical services agencies. The age group was considered representative of the population at risk for out-of-hospital cardiac arrest (OHCA). The survey described ROC-ALPS and the opt-out option. Respondents were asked whether the study was important to do, whether the benefits justified doing it under EFIC, and whether they would be willing to be enrolled in the study. Responses were recorded using a five-point Likert scale. Demographic information collected included age, gender, and race. Descriptive statistics were used to tabulate responses to survey questions. Pearson chi-square test was used for subgroup analyses. **Results.** Of the 2,000 mailed surveys, 1,951 were delivered and 337 were returned (17.2% response rate). The respondents were 48.8% male, with a mean age of 63.1 years. Most respondents were white (89.3%) and representative of the study community. A majority (88.3%) of the respondents agreed that EFIC research is important, and 73.9% felt that the benefits justify this method of research. Fewer respondents (53.1%) expressed a willingness to be enrolled in ROC-ALPS. There were no gender differences in question response. More respondents under the age of 65 years expressed a willingness to be enrolled in the study ( $p = 0.002$ ). However, those  $\geq 65$  years old were more likely to agree that the benefits justify the risk in EFIC studies ( $p = 0.029$ ). **Conclusions.** A majority of at-risk HMO community member respondents expressed support for EFIC research, and more than half expressed a willingness to be enrolled in the ROC randomized placebo-controlled ALPS study. The response rate was low, and differences were identified between respondents in relation to age.

### 36. THE INTERACTION OF CHEST COMPRESSION RATES WITH THE IMPEDANCE THRESHOLD DEVICE AND ASSOCIATION WITH SURVIVAL FOLLOWING OUT-OF-HOSPITAL CARDIAC ARREST

**Ahamed Idris, Danielle Guffey, Paul Pepe, Siobhan Brown, Tom Aufderheide, Steven Brooks, Clifton Callaway, Jim Christenson, Daniel Davis, Mohamud Daya, Randal Gray, Peter Kudenchuk, Jonathan Larsen, Steven Lin, James Menegazzi, UT Southwestern Medical Center**

**Background.** The Resuscitation Outcomes Consortium (ROC) PRIMED trial found no difference in survival to hospital discharge with a modified Rankin score (MRS)  $\leq 3$  with standard cardiopulmonary resuscitation (CPR) plus a sham versus active impedance threshold device (ITD) when used by emergency medical services (EMS) in adults with out-of-hospital cardiac arrest. We evaluated the potential interaction of chest compression rate with the sham versus active ITD and outcome. **Methods.** Data were abstracted from monitor-defibrillator recordings during the first 5 minutes of CPR in patients enrolled in the ROC PRIMED ITD Trial. We retrospectively estimated the interaction between compression rate and ITD on survival to hospital discharge

with MRS  $\leq 3$ . We fit a natural cubic spline curve to characterize the relationship between compression rate and outcomes. **Results.** Of 8,755 patients enrolled from June 2007 to November 2009, 6,188 had chest compression rate and fraction data and 4,170 also had chest compression depth data available, constituting the final study population. The mean age was 68 years. The mean chest compression rate was 106 compressions/min. The unadjusted cubic spline curves showed that peak survival for the sham and active ITD groups occurred at chest compression rates of 118 and 101 compressions/min, respectively ( $p = 0.47$ ). Peak survival with MRS  $\leq 3$  occurred at 118 and 99 compressions/min for the sham and active ITD groups, respectively ( $p = 0.58$ ). After adjustment for gender, age, bystander CPR, arrest location, ROC site, first EMS rhythm, witnessed status, and quality of CPR (chest compression fraction and depth), the interaction between rate and ITD for survival with MRS  $\leq 3$  was statistically significant ( $p = 0.036$ ), but not for all survival irrespective of MRS score ( $p = 0.093$ ). **Conclusion.** In the adjusted model, we observed a significant chest compression rate-dependent interaction with active ITD use for survival with MRS  $\leq 3$ . Optimal CPR rates were different with standard CPR and a sham versus active ITD.

### 37. SLOW CHEST COMPRESSION RELEASE VELOCITY IMPAIRS HEMODYNAMIC POWER IN THE ABDOMINAL AORTA

**Joshua Lampe, Josiah Garcia, Tai Yin, George Bratinov, Christopher Kaufman, Lance Becker, University of Pennsylvania**

**Background.** Research has suggested that chest compression (CC) release velocity or waveform impacts cardiopulmonary resuscitation (CPR) effectiveness. However, the impact of changes in CC waveform on blood flow and pressure in the abdominal aorta (AA) during prolonged CPR has not been thoroughly investigated. **Methods.** CPR hemodynamics in eight domestic swine ( $\sim 30$  kg) were studied using standard physiologic monitoring. A flow probe was placed on the AA and a pressure catheter tip was located in a corresponding region. Ventricular fibrillation (VF) was electrically induced. Mechanical CCs were started after 10 minutes of untreated VF. CC release was adjusted so that sternal recoil lasted 100 ms, 200 ms, or 300 ms. CCs were delivered over 54 minutes at a rate of 100/min and at a depth of 1.25 in. Transitions between waveforms occurred every 2 minutes and were randomized. Hemodynamic power was calculated as flow  $\times$  pressure. A peak decay phase was identified during which the drop in power over time became exponential. **Results.** Peak decay in AA power started after approximately 12 minutes of CPR. Pairwise comparisons indicated a significant effect of CC waveform. Transitioning from 300-ms to 100-ms release time increased average AA power by  $8.5\% \pm 13.6\%$ , while the reverse transition caused a decrease of  $-14.1\% \pm 14.1\%$  ( $p < 0.001$ ). Transitioning from 200-ms to 300-ms release time had a similar negative effect on AA power ( $-8.7\% \pm 8.4\%$ ), whereas comparisons between 100-ms and 200-ms release times showed no significant difference. **Conclusions.** CC release velocity significantly alters abdominal aortic hemodynamic power during prolonged CPR. Faster release velocities were associated with preserved or improved power, whereas slower release velocities were associated with significant reductions in power. Further research is required to determine how best to take advantage of the power difference between waveforms.

### 38. CHEST COMPRESSION RATES BETWEEN 100 AND 120 PER MINUTE ARE INDEPENDENTLY ASSOCIATED WITH INCREASED ADULT SURVIVAL FOLLOWING OUT-OF-HOSPITAL CARDIAC ARREST

**Ahamed Idris, Daniel Davis, Clifton Callaway, Jim Christenson, Peter Kudenchuk, Jonathan Larsen, Steven Lin, James Menegazzi, Kellie Sheehan, George Sopko, Mohamud Daya, Randal Gray, Ian Stiell, Graham Nichol, Danielle Guffey, UT Southwestern Medical Center**

**Background.** American Heart Association cardiopulmonary resuscitation (CPR) guidelines recommend a chest compression rate of at least 100 compressions/min, but provide no guidance for an upper rate limit. The objective of this study was to assess the relationship between chest compression rates used by emergency medical services (EMS) providers and survival to hospital discharge after out-of-hospital cardiac arrest (OHCA). **Methods.** Adults ( $\geq 20$  years) with OHCA treated by EMS providers were enrolled in the Resuscitation Outcomes Consortium (ROC) PRIMED study. Data were abstracted from monitor-defibrillator recordings for the first 5 minutes of CPR. Multiple logistic regression assessed the odds ratio (OR) for survival by compression rate categories ( $< 80$ , 80–99, 100–119, 120–139,  $\geq 140$ /min), unadjusted and adjusted OR for gender, age, witnessed status, attempted bystander CPR, location of arrest, chest compression fraction and depth, rhythm, and ROC site. We used a global test of association to assess significance. **Results.** 10,371 patients with OHCA had CPR from June 2007 to November 2009 with compression rate available; 6,399 also had chest compression fraction and depth data. The mean ( $\pm$  standard deviation [SD]) age was  $67 \pm 16$  years. The mean ( $\pm$ SD) compression rate was  $111 \pm 19$ /min, compression fraction was  $0.66 \pm 0.16$ , and compression depth was  $42 \pm 12$  mm. Return of spontaneous circulation occurred in 34%, and 9% survived to hospital discharge. The adjusted model (without chest compression depth and fraction) did not show a significant relationship between chest compression rate categories and survival ( $p = 0.19$ ). However, in the subgroup of subjects with compression depth data, the global test found a significant relationship between chest compression rate categories and survival, both with an adjustment for compression depth and fraction ( $p = 0.02$ ) and without ( $p = 0.02$ ). **Conclusion.** Survival to hospital discharge after OHCA is greater when chest compression rates are maintained in a range of 100 to 120/min.

### 39. CHANGES IN TISSUE OXIMETRY DURING THE SPECTRUM OF CARDIAC ARREST AND RESUSCITATION IN A PORCINE MODEL

**Joshua Reynolds, David Salcido, Adam Frisch, Brian Suffoletto, James Menegazzi, University of Pittsburgh**

**Background.** Intensive monitoring during resuscitation remains relatively crude and is difficult in the prehospital environment. Near-infrared spectroscopy (NIRS) noninvasively measures real-time tissue oxygen content by approximating the hemoglobin oxygen saturation fraction in terminal vasculature of tissue. Using our established porcine model of out-of-hospital cardiac arrest (OHCA), we assessed the utility of continuous tissue oxygen saturation (StO<sub>2</sub>) measurement throughout the spectrum of resuscitation. Our hypothesis was that StO<sub>2</sub> will decrease with loss of pulses, increase with resuscitation measures (cardiopulmonary resuscitation [CPR] and administration of epinephrine), and return to baseline with return of spontaneous circulation

(ROSC). **Methods.** We anesthetized and instrumented seven female swine, placing a noninvasive NIRS probe on the left forelimb that recorded continuous  $StO_2$ . After 8 minutes of untreated ventricular fibrillation and 2 minutes of mechanical CPR, we randomized the animals to 0.015 mg/kg (SDE) or 0.1 mg/kg (HDE) epinephrine. After 3 additional minutes of CPR, the animals were defibrillated (150 J biphasic). We attempted subsequent defibrillations using quantitative waveform measures to guide shock delivery. Data were analyzed with descriptive statistics and a generalized linear model with  $\alpha = 0.05$  to determine the overall slope of the pooled  $StO_2$  across animals for each segment of resuscitation. **Results.** The mean weight was  $29.7 \pm 1.9$  kg and the mean anesthesia duration was  $67.4 \pm 13.0$  minutes. Four animals received HDE and three SDE. All animals achieved ROSC. Significant coefficients ( $StO_2/\text{min}$ ) were noted for each segment of resuscitation. The  $StO_2$  rapidly decreased immediately after loss of pulses ( $-29.1$ ; 95% confidence interval [CI]  $-33.4$ ,  $-24.7$ ;  $p < 0.01$ ), taking  $31.2 \pm 7.8$  seconds to decrease by 25%. It did not change during during CPR ( $-0.2$ ; 95% CI  $-1.2$ ,  $0.8$ ;  $p = 0.71$ ). There was a graded decline in  $StO_2$  between SDE ( $-1.3$ ; 95% CI  $-1.5$ ,  $-1.2$ ;  $p < 0.01$ ) and HDE ( $-3.1$ , 95% CI  $-5.8$ ,  $-0.4$ ;  $p = 0.03$ ). The slowest change occurred with ROSC (0.4; 95% CI 0.3, 0.5;  $p < 0.01$ ), taking  $10.2 \pm 0.8$  minutes to increase by 25%. **Conclusions.** In our porcine model of OHCA, peripheral  $StO_2$  rapidly decreased after loss of pulses, but did not improve with CPR or epinephrine. It increased extremely slowly after ROSC. Peripheral  $StO_2$  may be a useful indicator of "pulselessness" in critically ill prehospital patients (especially pulseless electrical activity, which is not detected by electrocardiography), but does not appear to be a rapid indicator of ROSC.

#### 40. CORONARY PERFUSION PRESSURE RESPONSE TO INTRAOSSEOUS EPINEPHRINE ADMINISTRATION AFTER PROLONGED CARDIAC ARREST

Joshua Harris, Ryan Coute, Adam Kellogg, Scot Millay, Timothy Mader, Baystate Medical Center

**Background.** While provision of vasopressors during attempted resuscitation of out-of-hospital cardiac arrest (OHCA) victims has never been shown to improve neurologically intact survival, its short-term benefits are clear. Despite evidence that the intraosseous (IO) dose should be substantially higher than that given intravenously (IV) to achieve pharmacokinetic and hemodynamic equivalency, current guidelines still recommend a dose of 0.01 mg/kg regardless of delivery route (IO or IV). **Objective.** To compare the effect of epinephrine 0.1 mg/kg (HDE) IO with 0.01 mg/kg (SDE) IV on coronary perfusion pressure (CPP) during resuscitation in a swine model of prolonged ventricular fibrillation (VF). **Methods.** This was a secondary analysis of prospectively collected data from two Institutional Animal Care and Use Committee (IACUC)-approved protocols. Seventy-nine Yorkshire swine (25–30 kg) were surgically instrumented under anesthesia and VF was electrically induced. After 10 minutes of untreated VF in the IO study ( $n = 26$ ) and 12 minutes of untreated VF in the IV study ( $n = 53$ ), resuscitation commenced with precordial chest compressions. After 30 seconds of initial chest compressions, a single dose of epinephrine (HDE IO or SDE IV) was given followed by a large-volume saline flush. An additional 2.5 minutes of compressions was provided after injection to circulate the medication before the first rescue

shock (RS) was delivered. Cardiopulmonary resuscitation (CPR) and RS attempts were standardized for all animals. The CPP was defined as aortic diastolic pressure minus right atrial diastolic pressure and the values were extracted immediately following the last compression before defibrillation for the first RS in each animal. Descriptive statistics were used to analyze the data. **Results.** After 10 minutes of untreated VF, HDE IO epinephrine resulted in a mean CPP of 33.2 mmHg (95% confidence interval [CI]: 26.6, 39.9) just prior to the first RS. After 12 minutes of untreated VF, SDE IV epinephrine resulted in a mean CPP of 25.0 mmHg (95% CI: 20.5, 29.4) just prior to the first RS. **Conclusion.** This observation study reaffirms the assertion that HDE may be required to generate CPP values similar to SDE delivered IV during resuscitation of prolonged VF. A randomized comparison of HDE and SDE IO in the metabolic phase of VF is needed to test this hypothesis and determine the impact on ROSC and short-term survival.

#### 41. REGIONAL VARIATION IN POST-CARDIAC ARREST CARE—A STATEWIDE EVALUATION

Robert Swor, Kelly Sawyer, Carol Clark, Carman Turkleson, David Haines, William Beaumont Hospital

**Background.** There is an evolving body of literature advocating for regional post-cardiac arrest systems of care. We sought to describe the variation in post-cardiac arrest care provided in a single large state. **Methods.** We used the Michigan Inpatient Data Base (MIDB) to evaluate care provided to post-cardiac arrest patients from July 2008 to June 2011. The MIDB is a comprehensive source of inpatient activity at Michigan acute care hospitals. We included all patients admitted with *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) diagnoses of cardiac arrest (ICD 427.5) or ventricular fibrillation (427.41). Data were collated regarding patient demographics, final diagnoses, and procedures performed: therapeutic hypothermia (TH), percutaneous coronary intervention (PCI), implantable cardiac defibrillator (ICD) placement, and coronary artery bypass grafting (CABG). We evaluated variation in care by region, using the eight-state designated medical emergency care regions (MECR), which are designed to facilitate disaster, trauma, and cardiac care. Descriptive statistics, correlation coefficients, and chi-squares were calculated. **Results.** During the study period, there were 21,856 patients with cardiac arrest admitted, with 9,014 (41.2%) discharged. Rates of TH increased by year (0.7%, 1.7%, 2.2%;  $p < 0.001$ ). Significant regional variation in postarrest care was observed for TH (range 0.3% to 3.9%,  $p < 0.001$ ). There was also significant variation by region in the rates of PCI, CABG, and ICD. Patients with the diagnosis of VF were more likely to receive TH (2.3% vs. 1.2% [odds ratio 1.9; 95% confidence interval 1.5, 2.3]), and varied more than eightfold by region (0.6% to 5.1%,  $p < 0.001$ ). There was no correlation between the rate of TH provision and the rate of other interventional cardiac care procedures or regional cardiac arrest case volume. **Conclusion.** Use of TH is increasing in Michigan, and greater than 10-fold variation in the rate of TH provision between state regions was observed. Significant regional variation exists for post-cardiac arrest interventional care. Regional rates of provision of TH did not correlate with interventional cardiac care, or cardiac arrest case volume. These data suggest that identification of comprehensive regional cardiac arrest centers based on volume or ability to provide services may not result in TH care for postarrest patients.

#### 42. COMPARISON OF PREHOSPITAL CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) NONINVASIVE VENTILATION DEVICES' ABILITY TO MAINTAIN CPAP OVER TIME IN A SIMULATED LUNG MODEL

Ryan Hodnick, Daniel Barela, David Slattery, Darren Braude, Bryan Bledsoe, University of Nevada

**Background.** Prehospital continuous positive airway pressure (CPAP) devices are highly variable in terms of cost, design, and ability to maintain continuous airway pressures. Oxygen consumption and CPAP maintenance become crucial factors as transport times increase. **Objective.** To compare various CPAP devices with regard to useful operating time (UOT), defined as the duration the device maintained any continuous airway pressure (CDOT0) on standardized settings. **Methods.** Prospective, observational study. Inclusion criteria: CPAP devices approved for prehospital use as of November 2011 (CAREvent, PortO<sub>2</sub>Vent, Oxy-PEEP, O<sub>2</sub>-ResQ, MACS CPAP, Boussignac, Flow Safe, and WhisperFlow). Exclusion criteria: Prehospital ventilators capable of delivering CPAP. CPAP devices were attached to a standard D cylinder via a calibrated regulator. Each device's mask was tested using a Laerdal Airway Management Trainer attached to an IngMar Medical Demonstration Lung Model. The following settings were used: respiratory rate of 12 breaths/min, tidal volume of 500 mL, compliance of 34 mL/cmH<sub>2</sub>O, resistance set to normal physiologic value, and peak flow of 30 L/min. Each device was tested at a CPAP of 10 cmH<sub>2</sub>O. Devices that had a variable fractional concentration of oxygen in inspired gas (FiO<sub>2</sub>) were tested at the lowest and highest FiO<sub>2</sub> settings. Positive end-expiratory pressure (PEEP), a surrogate for CPAP, was directly measured using Pulmonary Mechanics Graphics 3000 Module software (IngMar). All times were recorded using a digital stopwatch. The primary performance measure was PEEP drop-off time 0 (CDOT0), defined as the time until complete loss of PEEP. We rank-ordered results by decreasing overall CDOT0 and stratified them by maximal and minimal FiO<sub>2</sub> values. **Results.** We measured eight devices, three of which were studied twice (maximal/minimal FiO<sub>2</sub> settings) and five of which were studied once, for a total of 11 trials. For the eight devices tested, the range of CDOT0 was from 4 minutes (WhisperFlow) to 78 minutes (Oxy-PEEP). CDOT0 (minutes:seconds) in decreasing performance was as follows: 1) Oxy-PEEP-32% (78:41); 2) MACS CPAP-65% (76:30); 3) PortO<sub>2</sub>Vent-100% (68:13); 4) WhisperFlow-28% (47:35); 5) MACS CPAP-100% (43:39); 6) O<sub>2</sub>-ResQ-30% (35:48); 7) CAREvent-100% (34:19); 8) Flow Safe-100% (31:15); 9) Boussignac-100% (30:05); 10) Oxy-PEEP-95% (28:16); and 11) WhisperFlow-100% (04:14). **Conclusion.** There is high variability in UOT among common CPAP devices. These findings may have important resource implications for emergency medical services agencies.

#### 43. BODY TEMPERATURE OF BURN PATIENTS AT HOSPITAL ARRIVAL IN BURN PATIENTS PRESENTING TO PENNSYLVANIA BURN CENTERS FROM 2000 TO 2011

Matthew Weaver, Jon Rittenberger, Heather Kowger, P. Patterson, Serina McEntire, Alain Corcos, Jenny Ziembicki, David Hostler, University of Pittsburgh

**Background.** Prehospital burns require providers to limit further injury, expose the patient and provide initial treatment, and maintain normothermia. Little is known about temperature at hospital presentation

for emergency medical services (EMS)-treated burn patients. We characterized temperature at hospital arrival for patients presenting to Pennsylvania burn centers. **Methods.** We analyzed 11 years of prehospital data from burn patients included in the Pennsylvania Trauma Outcomes Study registry (traumatic diagnoses of *International Classification of Diseases, Ninth Revision, Clinical Modification* [ICD-9-CM] 800–995 and documented burn injury). Our dependent variable of interest was temperature at hospital arrival—a continuous measure that we dichotomized into normothermia ( $>36.5^{\circ}\text{C}$ ) and hypothermia ( $\leq 36.5^{\circ}\text{C}$ ). We report the characteristics of these patients using descriptive statistics and evaluated factors associated with hypothermia using hierarchical logistic regression. **Results.** The data set included 8,025 records of patients transported by EMS. We excluded data from patients who died in the emergency department and those with missing temperature information. Our final data set included 7,616 records submitted by 22 institutions. Only 4,626 (61%) of the sample was normothermic upon hospital arrival. Of the remaining 39% ( $n = 2,990$ ), the median temperature was  $36.1^{\circ}\text{C}$ , interquartile range (IQR) 35.8–36.3, with 5% of the hypothermic patients presenting below  $35^{\circ}\text{C}$ . Hypothermic burn patients were more likely to have been paralyzed and intubated (odds ratio [OR] 1.99; 95 confidence interval [CI] 1.79–2.20) and to have arrived as a trauma alert (OR 1.52; 95 CI 1.39–1.66) and demonstrated a lower Glasgow Coma Scale score when compared with normothermic burn patients (median 15 [IQR 11–15] vs. median 15 [IQR 15–15];  $p < 0.01$ ). Temperature on arrival was most commonly measured via oral or tympanic methods in both groups. The majority of patients experienced thermal burns (73.8%), and 55% had less than 10% total second- and third-degree total burn surface area. The normothermic patients were younger than the hypothermic group (median 27 years [IQR 9–47] vs. median 34 years [IQR 14–52];  $p < 0.01$ ). The two groups also varied with respect to method of transport ( $p < 0.01$ ) and type of burn injury ( $p = 0.03$ ). **Conclusions.** In this large sample, nearly 40% of burn patients transported by EMS arrived at the hospital mildly hypothermic. Clinical characteristics suggest these patients may have been more severely injured. Maintenance of normothermia and good resuscitation practices should be stressed to EMS providers.

#### 44. PROMOTING EARLY INTERVENTION DURING SIMULATED HEMORRHAGE WITH THE USE OF A REAL-TIME DECISION-ASSIST ALGORITHM

**Victor Convertino, Gary Muniz, David Wampler, Craig Manifold, Greg Grudic, Steven Moulton, Robert Gerhardt,**  
*United States Army Institute of Surgical Research*

**Background.** Lifesaving interventions required to effectively treat trauma patients with significant hemorrhage can be delayed, leading to poor outcomes, when critical care personnel rely on standard vital signs obtained from current medical monitors. Using new monitoring technologies, we developed a machine-modeling algorithm that accurately identifies loss of central blood volume and provides an early prediction of the point at which an individual will experience hemodynamic instability (onset of shock). A real-time comprehensive physiologic monitor algorithm reduces the time a paramedic will identify an unstable computer simulated hemorrhaging patient. **Methods.** Fifty paramedics reviewed a monitor screen that displayed standard vital signs during a simulated hemorrhage profile

on two different occasions, once with and once without a decision-support algorithm designed to show real-time tracking of physiologic responses directly associated with changes in central blood volume. The paramedics were asked to push a computer key only if there was an indication from the monitor that led them to believe the patient's condition had become unstable. **Results.** The mean time required by the paramedics to identify an unstable patient was  $18.3 \pm 4.1$  minutes without the algorithm and  $10.7 \pm 4.2$  minutes with the algorithm. Using the algorithm reduced the response time by  $>40\%$  ( $p < 0.001$ ). **Conclusion.** These data demonstrate that algorithms with real-time tracking of physiologic responses associated with loss of circulating blood volume can lead to earlier intervention of a bleeding patient. A real-time comprehensive physiologic monitor algorithm reduces the time a paramedic will identify an unstable, computer-simulated hemorrhaging patient.

#### 45. SPINE INJURIES IN MOTORSPORTS, THE INDIANAPOLIS STYLE PROFESSIONAL RACING EXPERIENCE

**Andrew Stevens, Terry Trammell, Geoffrey Billows, Michael Olinger,**  
*Indiana University School of Medicine*

**Background.** Emergency medical services (EMS) focuses on rapid assessment and transportation of motor vehicle crash victims. Patients with serious “mechanism of injury” are extricated from the vehicle and placed in spinal immobilization. Upon transport to the hospital, it is common for immobilized patients to receive whole-body computed tomography (CT) to rule out life-threatening injuries. In contrast, drivers in the Indianapolis Style Racing Series involved in high-speed (often greater than 200 mph) accidents commonly self-extricate and are often transported to medical facilities without cervical collars or backboards. It is not known, however, whether driver-initiated self-extrication increases the risk of neurologic injury after spinal fracture. Our objective was to evaluate the safety of self-extrication in Indianapolis Style Racing by comparing the use of CT scans, need for surgery, and neurologic outcomes of spinal fractures in drivers who self-extricated compared with those who required EMS-facilitated extrication. **Methods.** We conducted a retrospective review of Indianapolis Style Racing Drivers' medical records between the years of 2006 and 2011. Cumulative radiation exposure, need for surgery, and reported neurologic outcomes were obtained from medical records. This time period represents compulsory head and neck support (HANS) and unified chassis design, and all venues had installed Steel And Foam Energy Reducing (SAFER) barriers. Inclusion criteria were involvement in a crash incident and alert upon initial evaluation. **Results.** We examined 135 crash incidents. Self-extrication occurred in 121 (90%) and overall cumulative radiation exposure ranged from 100 to 250 mSv or 0.82 to 2.06 mSv per driver. During this study period, 14 (10%) drivers were extricated and immobilized and the overall cumulative radiation exposure ranged from 140 to 350 mSv or 10 to 25 mSv per driver. A total of 29 injuries were identified. Spinal injury included nine (31%) of these injuries. Six EMS-extricated and three self-extricated drivers had a spinal injury. Zero of these had surgical disease or neurologic deficit on follow-up. One driver was excluded because of multiple trauma severity upon presentation. **Conclusion.** In our Indianapolis Style Racing experience, a protocol-led self-extrication system did not miss any surgical spine injuries regardless of mechanism of injury in this

cohort of patients and reduced group-averaged radiation exposure.

#### 46. EFFECT OF EMS AIRWAY SELECTION ON NEUROLOGIC STATUS OF SURVIVORS AFTER OUT-OF-HOSPITAL CARDIAC ARREST

**Jason McMullan, Ryan Gerecht, Jordan Bonomo,**  
*University of Cincinnati*

**Background.** Early airway data suggest that supraglottic airways (SGAs) impair cerebral perfusion. A post hoc analysis of a clinical trial suggests that there may be a beneficial impact on neurologically intact survival with the use of endotracheal tube (ETT) use in out-of-hospital cardiac arrest (OHCA), but this has not been evaluated in an unselected OHCA population. This preliminary analysis was performed to support a larger effort investigating the association of airway choice on functional status after OHCA. We hypothesized that there would be no difference in functional outcome in this small unselected population. **Methods.** OHCA patients who survived to hospital admission and had an ETT or SGA placed by emergency medical services (EMS) between January 1, 2011, and April 30, 2012, were selected from the CARES registry of an urban fire-based EMS system. Patients with no EMS airway, unknown airway, or unknown neurologic status at discharge were excluded. Groups were compared with chi-square analysis. Good functional outcome was defined as a cerebral performance category (CPC)  $<3$ . **Results.** Overall, 81 of 284 (28.5%) OHCA patients survived to hospital admission during the study period, and 61 were included for analysis (excluded: 1 unknown airway, 2 unknown neurologic status, 17 no airway). There was no observed difference in subject (age, race, gender) or OHCA (witnessed, initial rhythm, bystander cardiopulmonary resuscitation) characteristics. Five of 27 (18.5%) with ETT and seven of 34 (20.5%;  $p = \text{ns}$ ) with SGA were discharged with good neurologic status. **Conclusion.** In this small preliminary analysis, there is not a large difference in functional outcome in survivors of OHCA with SGA or ETT airway selection.

#### 47. THE IMPACT OF PREHOSPITAL NONINVASIVE POSITIVE PRESSURE SUPPORT VENTILATION IN ADULT PATIENTS WITH SEVERE RESPIRATORY DISTRESS: A SYSTEMATIC REVIEW AND META-ANALYSIS

**Sameer Mal, Shelley McLeod, Alla Iansavichene, Adam Dukelow, Michael Lewell,**  
*University of Western Ontario*

**Background.** Noninvasive positive pressure ventilation (NIPPV), which includes continuous and bilevel pressure modalities, has been shown to reduce mortality, intubation rates, and intensive care unit (ICU) length of stay (LOS) for patients admitted to hospital with acute pulmonary edema and acute exacerbation of chronic obstructive pulmonary disease. NIPPV is increasingly being used by emergency medical services (EMS) agencies for the treatment of respiratory distress in the prehospital setting. The primary objective of this systematic review was to determine whether prehospital administered NIPPV for the treatment of adults with severe respiratory distress reduces 30-day mortality as compared with “standard” therapy. Secondary objectives were to examine the effect of prehospital-administered NIPPV on the need for invasive ventilation, ICU LOS, and hospital LOS. **Methods.** Electronic searches of Medline, EMBASE, Cochrane Central Register of Controlled Trials, and CINAHL were conducted, and reference lists for relevant articles were hand-searched. Randomized controlled trials comparing

the use of prehospital NIPPV with standard therapy in adults (age >16 years) with severe respiratory distress published in the English language were included. Two reviewers independently screened the titles and abstracts, assessed the quality of the studies, and independently extracted data. Where appropriate, data were pooled using random-effects models and reported as risk ratios (RRs) with 95% confidence intervals (CIs) and number needed to treat (NNT). **Results.** Six randomized controlled trials were included with a combined total of 583 patients: 289 in the standard therapy group and 294 in the NIPPV group. In patients treated with prehospital NIPPV, the pooled estimate showed a reduction in both 30-day mortality (RR: 1.67; 95% CI: 1.01, 2.78; NNT = 18) and need for invasive ventilation (RR: 2.59; 95% CI: 1.66, 4.05; NNT = 8). There was no difference in ICU or hospital LOS. **Conclusion.** Out-of-hospital administration of NIPPV appears to be an effective therapy for adult patients with severe respiratory distress.

#### 48. AIRTRAQ VERSUS MACINTOSH LARYNGOSCOPE FOR MANIKIN INTUBATION DURING ACTIVE CARDIOPULMONARY RESUSCITATION

Gregory Reimer, Erin Weldon, R. Grierson, Travis Hildebrand, *University of Manitoba*

**Background.** Advanced airway placement during active cardiopulmonary resuscitation (CPR) has been associated with prolonged pauses in chest compressions and worse patient outcomes. The Airtraq indirect laryngoscope has been proven to be a useful difficult airway adjunct and may have an advantage over traditional direct laryngoscopy with respect to ease and timeliness of endotracheal tube placement during continuous cardiopulmonary resuscitation (CPR) in the prehospital setting. The purpose of our study was to determine whether the Airtraq indirect laryngoscope would positively affect intubation outcomes in manikins with and without active chest compressions. **Methods.** We carried out a randomized crossover study comparing traditional direct laryngoscopy with the Airtraq indirect laryngoscope in a simulated setting. Eighty-five experienced paramedics participated in four intubation scenarios: 1) Macintosh laryngoscope without chest compressions, 2) Macintosh laryngoscope during continuous chest compressions, 3) Airtraq laryngoscope without chest compressions, and 4) Airtraq laryngoscope during continuous chest compressions. Following all intubation scenarios, the participants voluntarily completed a six-question survey. Primary outcomes were success rate, time to intubation, and number of intubation attempts. Secondary outcomes included view of the larynx and ease of intubation. **Results.** The Airtraq laryngoscope did not improve success rate, decrease time to intubation, or decrease the number of intubation attempts ( $p > 0.05$ ) with or without active CPR. Based on visual analog scores, the participants subjectively found that the Airtraq provided a superior view of the larynx compared with the Macintosh laryngoscope ( $p < 0.0001$ ). Overall, the participants found it easier to intubate with the Airtraq both in the manikin at rest and during active CPR ( $p < 0.0001$ ). **Conclusion.** The Airtraq indirect laryngoscope performs similarly to the Macintosh direct laryngoscope in terms of paramedic success rate, time to intubation, and number of intubation attempts in manikins with or without active chest compressions. Subjectively, the Airtraq provides a better view of the larynx and allows for easier intubation with and without chest compression. Further studies are warranted to determine whether the Airtraq laryngoscope is superior in a human patient population.

#### 49. PEAK INSPIRATORY PRESSURES DURING VENTILATION OF THE KING LARYNGEAL TUBE AIRWAY WITH A TRANSPORT VENTILATOR IN THE PREHOSPITAL SETTING

Christian Martin-Gill, Heather Prunty, Seth Ritter, Jestin Carlson, Francis Guyette, *University of Pittsburgh*

**Background.** Supraglottic airways, including the King laryngeal tube (LT), are widely used in the prehospital setting after failed endotracheal intubation or as primary airways in cases of suspected difficult intubation. While peak inspiratory pressures (PIPs) of greater than 30 cmH<sub>2</sub>O have been associated with air leak and gastric insufflation, the incidence of high PIP and the frequency of these adverse events during LT use with a transport ventilator are unknown. **Methods.** We conducted a retrospective review of LT use (King LT or King LTS-D) with a transport ventilator by a large helicopter emergency medical service from January 1, 2006, to August 31, 2011. We identified all cases transported after LT placement and collected demographics, transport time on the ventilator, initial PIP, end-tidal carbon dioxide (ETCO<sub>2</sub>), oxygen saturation (SpO<sub>2</sub>), and incidence of complications. Standard ventilator settings were assist control, tidal volume 8 mL/kg, rate 12 respirations/min, positive end-expiratory pressure (PEEP) 5 cmH<sub>2</sub>O, and fractional concentration of oxygen in inspired gas (FiO<sub>2</sub>) 100%. We used descriptive statistics with 95% confidence intervals (CIs). **Results.** A transport ventilator was used in 49 of 146 (34%) cases of LT placement. Nine cases were excluded because of inadequate documentation. Of the 40 patients analyzed, 57% were male, the average age was 53.2 years, 26 cases (65%) involved a traumatic mechanism, 36 patients (90%) received rapid-sequence intubation, and no patients were in cardiac arrest at the time of airway placement. Mechanical ventilation occurred for a mean of 22.4 minutes (95 CI 15.4–29.5). Mean initial PIP was 31.8 cmH<sub>2</sub>O (CI 27.8–35.8), and 18 patients (45.0%) had PIP >30 cmH<sub>2</sub>O. The initial and final ETCO<sub>2</sub> readings were 47.1 mmHg (95 CI 42.1–52.1) and 37.8 mmHg (95 CI 34.0–41.5). The initial and final SpO<sub>2</sub> readings were 93.0% (95 CI 89.8–96.2) and 96.6% (95 CI 94.5–98.6). Mechanical ventilation was discontinued in five patients (13%, 95 CI 3–23%) because of elevated PIP ( $n = 3$ , 8%, 95 CI 0–16%) or hypoxia ( $n = 2$ , 5%, 95 CI 0–12%). One patient with a PIP <30 cmH<sub>2</sub>O vomited and required suctioning through the LT's gastric port. **Conclusion.** Peak inspiratory pressures above 30 cmH<sub>2</sub>O are common during mechanical ventilation through an LT airway, yet the majority of patients are adequately ventilated and oxygenated. Caution should be taken to monitor for elevated PIP, and gastric decompression should be performed when possible.

#### 50. FACILITATION OF UNINTERRUPTED CHEST COMPRESSIONS BY PARAMEDICS: THE ROLE OF THE VIDEO LARYNGOSCOPE

Samantha Kealey, Aaron Burnett, Kent Griffith, Sandi Wewerka, Joshua Salzman, Zabrina Evens, Ralph Frascione, *Regions Hospital*

**Background.** New American Heart Association guidelines emphasize the importance of uninterrupted chest compressions (CCs) in cardiac arrest. Recent studies suggest that direct laryngoscopy (DL) in the field contributes to significant pauses in CCs. The aim of this study was to examine the role of video laryngoscopes (VLs) in facilitating uninterrupted CCs for prehospital cardiac arrest patients. **Methods.** This was a post hoc analysis from a multisite, prospective, nonrandomized, crossover trial comparing the placement success rates of two VLs

(CMAC, Karl Storz; King VISION [KV], King Systems). Inclusion criteria for this analysis consisted of need for advanced airway management and cardiac arrest as the primary impression. Patient, provider, and clinical demographics were compared between treatment arms. The associations between ongoing CCs and device type, as well as CCs and attempt success, were examined using a chi-square test. An attempt was defined as the tip of the VL blade passing the patient's lips. **Results.** There were no demographic differences (provider or patient) between the VL treatment groups. A total of 106 VL attempts (62 CMAC and 44 KV) were made by providers for 97 patients. Of the total attempts, 41.5% were made without stopping CCs, and there was no difference in placement success between attempts with interrupted compressions and continuous compressions (45% vs. 50%;  $p = 0.62$ ). There was no statistically significant difference between the frequency of KV and CMAC placement attempts with CCs (47.7% vs. 37.1%;  $p = 0.27$ ). Though the percentage of successful attempts with continued CCs appeared higher in the CMAC group (60.9% vs. 38.1%), the difference did not meet statistical significance ( $p = 0.13$ ). **Conclusion.** Overall, CCs were performed on 41% of attempts and more frequently, though not statistically significantly, with KV compared with CMAC. CMAC appeared to have a higher success rate while CCs are ongoing when compared with KV. Though this study did not specifically determine which VL device might better facilitate endotracheal intubation (ETI) with uninterrupted CCs, it did show a large percentage of successful VL intubations without pauses in CC. Future research directly comparing ETI using VL versus DL may establish a permanent place for VL in out-of-hospital cardiac arrest.

#### 51. SUCCESS OF OUT-OF-HOSPITAL PEDIATRIC ENDOTRACHEAL INTUBATIONS PERFORMED BY FLIGHT NURSES AND PARAMEDICS

Sean Button, Christian Martin-Gill, Mioara Manole, Francis Guyette, *Children's Hospital of Pittsburgh*

**Background.** Bag-valve-mask ventilation (BVM) is the preferred method of pediatric ventilatory support in the out-of-hospital setting. However, there is no consensus regarding the optimal method for pediatric airway management during long transports performed by critical care providers with rigorous training and ongoing experience. The purpose of this study was to describe the incidence of intubation success, first-pass success, immediate complications, adequacy of ventilation, and correct choice of tube size for pediatric intubations performed by flight nurses and paramedics. **Methods.** We retrospectively reviewed all intubation attempts performed by a large regional helicopter emergency medical service (HEMS) in patients transported to a single pediatric tertiary care center. We included patients less than 18 years old intubated by flight nurses and paramedics from January 2003 to December 2011. We recorded the age, gender, reason for intubation, number of attempts, initial and final end-tidal carbon dioxide (EtCO<sub>2</sub>) and oxygen (O<sub>2</sub>) saturations, and endotracheal tube (ETT) size. We also reviewed the hospital record to identify immediate complications, including missed esophageal intubation, pneumothorax, mainstem intubation, and persistent hypoxia. **Results.** Intubation was attempted in 196 pediatric patients during the study period. The median patient age was 7 years (interquartile range [IQR] 3–13) with a weight of 35 kg (IQR 20–50). The majority of children, 121 (63%), were intubated at the scene, while

the remainder were intubated at outlying facilities. The first-pass success rate was 85.2% (95% confidence interval [CI] 80.2–90.2%). Successful intubations were performed within three attempts in 97% of patients (95% CI 94.6–99.3%). There was one (0.5%, 95% CI 0–1.5%) unrecognized esophageal intubation, zero pneumothoraxes, and 25 (13%, 95% CI 8–18%) mainstem intubations identified at the receiving hospital. Only two patients (1.0%, 95% CI 0.4–2.4%) had hypoxia not corrected by the flight crew (saturation of peripheral oxygen [SpO<sub>2</sub>] <95%). Hypoventilation (EtCO<sub>2</sub> >45 mmHg) and hyperventilation (EtCO<sub>2</sub> <30 mmHg) occurred in 18 (9.2%, 95% CI 5–13%) and 29 (15%, 95% CI 10–20%) patients, respectively. ETT size was correctly chosen in 141 patients (74%, 95% CI 68–80%). **Conclusions.** In our series, HEMS nurses and paramedics performed successful intubations without complications in a vast majority of pediatric patients. Correct calculation of pediatric ETT size and depth may represent educational opportunities in our cohort of providers.

## 52. BARRIERS TO PEDIATRIC VITAL SIGN ASSESSMENT BY PREHOSPITAL PROVIDERS

**Kathleen Adelgais, Lara Rappaport, Jason Kotas, Kevin Waters, Maria Mandt, University of Colorado**

**Background.** Studies demonstrate that incomplete monitoring of vital signs (VS) by prehospital providers (PHPs) is common in children, while barriers to obtaining VS in children by PHPs have not been explored. Our objective was to test the content validity, face validity, and internal consistency of a survey designed to identify perceived barriers to obtaining VS in children. **Methods.** A draft survey was created after a review of the literature and non-structured interviews with PHP subject matter experts (SMEs) to develop content and ascertain certain beliefs surrounding barriers to VS assessment in children. The survey was then pilot-tested among additional SMEs for content validity and a convenience sample of PHPs on face validity and internal consistency. We assessed content validity with a five-point Likert scale. Cronbach's alpha tested internal consistency for beliefs, including familiarity with pediatric VS norms, utility of VS in management, and importance of VS in children. We evaluated the face validity of three case scenarios in different age groups depicting an uncooperative child created to evaluate PHP self-efficacy for pediatric VS assessment. **Results.** The survey was completed by seven SMEs and 22 PHPs. The average age was 38.4 years, 78% were male, the median number of years as a PHP was 15, and 90.1% reported practice location as urban/suburban. Of the SMEs, >90% gave a rating of >3 ("agree") for barriers and enablers to PHP VS assessment, with no recommended additional content. The PHPs agreed on the degree of cooperation for the infant and child age group case scenarios 72.7% and 90.0% of the time, respectively, with disagreement noted for the toddler case. Cronbach's alpha for familiarity with VS norms was 0.72, the utility of VS was 0.76, and the importance of VS was 0.86. Lack of equipment, patient compliance, and low pediatric call volume were reported by >80% of the PHPs as the greatest barriers to pediatric VS assessment. **Conclusion.** We have developed a survey tool with fair to excellent consensus on content and face validity and internal consistency to evaluate self-efficacy and perceived barriers to obtaining VS in children. Additional study into the impact of location, education, pediatric call volume, and equipment availability on PHP beliefs around VS assessment in children can be further explored.

## 53. A RETROSPECTIVE ANALYSIS OF COMPLICATIONS ARISING FROM INTRAOSSEOUS INSERTION DURING OUT-OF-HOSPITAL CARDIOPULMONARY RESUSCITATION IN ADULTS

**Andrew Wallace, Jose Cabanas, Valerie De Maio, Brent Myers, University of North Carolina**

**Background.** Intraosseous (IO) access is routinely used during resuscitation from out-of-hospital cardiac arrest (OHCA), yet there is a lack of data regarding complications in adults. The objective of this study was to identify complications from IO insertion in adult patients resuscitated from OHCA. **Methods.** This was a retrospective chart review of patients aged ≥16 years admitted to hospital after successful resuscitation from OHCA with IO access in an urban/suburban emergency medical services (EMS) system (population 900,000) from June 1, 2005, to December 31, 2009. Trauma cases were excluded. A literature review revealed a list of potential IO complications: osteomyelitis, periostitis, fracture, extravasation, compartment syndrome, cellulitis, skin abscess, ischemia, deep vein thrombosis (DVT), and pulmonary embolus (PE). Data abstracted by one observer to the study database from EMS and hospital records were demographics, medical history, IO insertion information, hospital course, and complications. Follow-up phone calls were made to survivors to screen for complications arising after hospital discharge. Analysis involved descriptive statistics with 95% confidence intervals (CIs). **Results.** This study included 217 adults aged 16 to 98 years, comprising 273 IO insertions. For insertions, 14 (5.1%, 95% CI 2.5–7.8%) had a defined complication, including compartment syndrome, 1 (0.4%); ischemic injury, 1 (0.4%); and extravasation, 5 (1.8%). One extravasation was associated with local necrosis. DVT occurred in five insertions (1.8%) and PE occurred in two insertions (0.7%). **Conclusion.** This is one of the first reports on IO complications in adults, and the complication rates reported here are comparable to the reports from pediatric populations and show that IO catheters are favorable to traditional intravenous catheters. Additionally, the DVT and PE rates in this study are similar to rates reported for hospitalized patients. IO appears to be a safe route for rapid vascular access in emergency situations, but further prospective evaluation is necessary to establish true complications rates.

## 54. THE IMPACT OF CPR DURATION ON SURVIVAL TO HOSPITAL DISCHARGE BETWEEN INTEGRATED AUTOPULSE CPR AND MANUAL CPR DURING OUT-OF-HOSPITAL CARDIAC ARREST OF PRESUMED CARDIAC ORIGIN

**Lars Wik, Jan Olsen, David Persse, Fritz Sterz, Michael Lozano, Marc Brouwer, Mark Westfall, Chris Souders, Reinhard Malzer, Pierre van Grunsven, David Travis, Ulrich Herken, James Brewer, E. Lerner, National Competence Center for Emergency Medicine**

**Background.** The Circulation Improving Resuscitation Care (CIRC) trial found equivalent survival in out-of-hospital cardiac arrest (OHCA) patients who received integrated AutoPulse cardiopulmonary resuscitation (iA-CPR) compared with high-quality manual CPR (M-CPR). We hypothesized that as prehospital CPR time increased, iA-CPR would provide a survival benefit when compared with high-quality M-CPR. **Methods.** A subgroup analysis of the CIRC randomized clinical trial was conducted. Patients were included in the CIRC trial if they had an OHCA treated by a participat-

ing emergency medical services (EMS) system in one of five study communities. Randomization occurred after manual compressions were initiated. Only those patients whose OHCA was EMS- or bystander-witnessed and had a shockable initial rhythm were included in this analysis. Duration of CPR was obtained from data recorded by the EMS defibrillator, and defined as the interval between the time the defibrillator was turned on and the time resuscitation was terminated or the time of the first documented return of spontaneous circulation. Logistic regression was used to model the interaction between treatment and length of resuscitation and was covariate-adjusted for trial site and patient age. The primary outcome was survival to hospital discharge. **Results.** 4,231 subjects were enrolled in the CIRC trial; 674 patients had witnessed shockable arrests. Of those, 621 had complete outcome and duration of CPR data (294 iA-CPR, 327 M-CPR). The logistic model had an overall p-value <0.0001 and a Hosmer-Lemeshow goodness-of-fit p-value of 0.20. The covariate-adjusted odds ratio for survival to hospital discharge in the iA-CPR arm was 1.49 compared with M-CPR with a p-value = 0.037 and a 95% confidence interval of 1.02 to 2.16. The odds ratio for survival to hospital discharge in favor of iA-CPR compared with M-CPR increased as the duration of resuscitation increased. iA-CPR had a survival benefit compared with M-CPR when the resuscitation duration was greater than 10 minutes. **Conclusion.** Compared with high-quality M-CPR, iA-CPR resulted in a statistically significant improvement in survival to hospital discharge for adult witnessed shockable OHCA patients with a longer duration of CPR.

## 55. AMPLITUDE SPECTRUM AREA-BASED DEFIBRILLATION DECISION GREATLY IMPROVES SHOCK SUCCESS RATE AND ACCURACY DURING PREHOSPITAL CARDIOPULMONARY RESUSCITATION

**Giuseppe Ristagno, Weilin Quan, Gary Freeman, Mario Negri Institute for Pharmacological Research**

**Background.** We retrospectively evaluated the capability of amplitude spectrum area (AMSA) to predict the likelihood that a defibrillation (DF) would restore a perfusing rhythm during cardiopulmonary resuscitation (CPR) in human victims of out-of-hospital cardiac arrest. We hypothesized that threshold values of AMSA could be identified to be used as a decision tool for CPR intervention, i.e., chest compression or DF, and such AMSA threshold would increase DF success rate and accuracy. **Methods.** Electrocardiographic (ECG) data, including 1,410 DF attempts, were obtained from 748 cardiac arrest patients from multiple areas in the United States. A 4-sec ECG window ending at 0.5 sec before DF was analyzed and AMSA was calculated prior to DF attempts. Successful DF was defined as return of an organized rhythm within 60 sec. For first and subsequent DFs, AMSA threshold values were analyzed with regard to their ability to discriminate among successful and unsuccessful DFs. The DF performance was then compared between two DF decision algorithms with and without AMSA threshold, respectively. **Results.** A total of 1,221 qualified DF events from 607 patients, with 578 first DF attempts and 543 subsequent ones for DF-resistant VF, were included in the analyses. For the DF decision algorithm without AMSA, the DF success rate and accuracy were 27% for the first DFs and 9% for the subsequent DFs, respectively. An optimized AMSA threshold was found to be 14 mV-Hz for first DFs and 12 mV-Hz for subsequent ones.

Incorporation of these AMSA thresholds into a DF decision algorithm increased both DF success rate and accuracy. The first DF achieved a DF success rate of 54% and an accuracy of 75%, while subsequent DF attempts achieved a DF success rate of 42% and an accuracy of 89%. These results translated into an increase of DF success rate and accuracy by 100% and 180% for the first DFs, and 360% and 880% for the subsequent DFs. **Conclusions.** In this population, a defibrillation decision algorithm incorporating an AMSA threshold was confirmed to be capable to predict DF success with high accuracy. An AMSA-based DF decision algorithm therefore should be a useful tool to guide CPR interventions.

**56. A COMPARISON OF COMPRESSION-RELATED INJURIES IN SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST TREATED WITH MANUAL VS. MECHANICAL CHEST COMPRESSION**

**Lori Boland, Paul Satterlee, Jonathan Hokanson, Craig Strauss, Dana Yost, Allina Health**

**Background.** Compressing the chest during cardiopulmonary resuscitation can result in injury. Previous reports on compression-related injuries in out-of-hospital cardiac arrest (OHCA) patients treated with manual vs. mechanical chest compression have relied exclusively on postmortem data. The purpose of this work was to examine the extent of injury conferred by manual vs. mechanical prehospital chest compressions among survivors of OHCA. **Methods.** A retrospective cohort study was conducted among survivors of nontraumatic OHCA who were discharged from hospitals belonging to a single health system between January 2009 and May 2012. Cases were eligible if the patient had received prehospital compressions from an emergency medical services (EMS) provider. One EMS provider in the area was using the LUCAS™ device as standard equipment for compression, while the remaining providers primarily used manual compression. Hospital records were reviewed for injuries documented during the postarrest hospitalization that likely resulted from compressions. Information about prehospital care was abstracted from EMS run sheets independently. **Results.** Among 117 eligible patients, 78 (67%) received manual compressions only and 39 (33%) received compressions predominantly with LUCAS. Thirteen injuries were identified in 10 unique patients (8.5%; 8 male, 2 female). The most common injuries were rib fractures (4/13; 31%) and hemorrhage (3/13; 23%). Imaging in the manual vs. mechanical groups was comparable, as was the prevalence of injury (8% vs. 10%, respectively,  $p = 0.64$ ). When compressions were performed for more than 10 minutes, injuries were more common (15% vs. 2% when compressions <10 minutes;  $p = 0.012$ ), but the prevalence of injury remained similar with manual (17%) vs. mechanical (14%) compression ( $p = 0.76$ ). The mean length of stay for those with and without injuries was 12.6 and 10.9 days, respectively ( $p = 0.42$ ). **Conclusion.** In this cohort of OHCA survivors, longer duration of compressions was crudely associated with a higher frequency of injury, while the use of mechanical compression was not. Compression-induced injuries are likely underestimated in this study as compared with autopsy studies, but these data suggest that injuries incurred among OHCA survivors are largely unattributable to mechanical compression and may be insignificant in terms of length of recovery.

**57. A NOVEL VIDEO CONTENT ANALYSIS SYSTEM FOR INTERACTIVE VIDEO LARYNGOSCOPY**

**Jestin Carlson, Samarjit Das, Fernando De la Torre, Adam Frisch, Francis Guyette, Jessica Hodgins, Donald Yealy, Saint Vincent Health Center**

**Background.** A key step in successful endotracheal intubation (ETI) is obtaining a satisfactory view of the glottic opening. To provide objective feedback about the quality of glottic visualization, we developed a computer vision algorithm that can automatically detect the glottic opening using machine learning techniques on videos collected during ETI. We sought to test the performance of this algorithm using video laryngoscopy. **Methods.** Seven participants trained in ETI performed 10 attempts each on a manikin using a video laryngoscope (C-MAC Karl Storz Corp., El Segundo, CA). Using 3-second epochs, we recorded either the presence or absence of the glottic opening on the screen. Data from the first five trials for each subject were used to train a computer vision algorithm, using image features known as the scale invariant feature transformation (SIFT), to represent either the presence or absence of the glottic opening (derivation cohort). Training used five different types of common classifiers: k-nearest neighbor (k-NN), support vector machine (SVM), decision trees, kernel logistic regression, and neural networks. We treated the presence of the glottic opening lasting less than 1 second as spurious, and these were removed from the analysis to further refine the classifiers. The five remaining trials per subject were used for testing the accuracy of the algorithm (validation cohort). **Results.** Because of difference in the length of time required for the 70 ETI attempts, 1,145 time periods were in the derivation cohort and 1,320 time periods were in the validation cohort. All classifiers had robust accuracy for detecting the glottic opening: k-NN 77%, SVM 77%, decision trees 74%, kernel logistic regression 76%, and neural networks 75%. The accuracy for automatically detecting the presence of glottic opening after postprocessing was 81% for both k-NN and SVM. **Conclusion.** We found that a computer algorithm can be trained to identify airway anatomy with good accuracy. This may allow creation of an interactive laryngoscopy tool to provide procedural guidance and objective skill assessments.

**58. ALTERNATIVE AIRWAY USE BY PARAMEDICS AFTER VIDEO LARYNGOSCOPE FAILURE**

**Zabrina Evens, Sandi Wewerka, Kent Griffith, Joshua Salzman, Samantha Kealey, Aaron Burnett, Ralph Frascone, Regions Hospital**

**Background.** Prehospital use of video laryngoscopes (VLs) remains rare. We analyzed the type, frequency, and overall success rates for alternative airway devices used when VL failed during a prospective prehospital research study. **Methods.** This was a post hoc analysis from a multisite, prospective, nonrandomized, crossover trial comparing the placement success rates of two VLs (Storz CMAC, Karl Storz; King VISION [KV], King Systems). Following failed airway management with a VL device, providers were allowed to choose their alternative device (ETI via direct laryngoscopy [DL], King, Combitube, or bag-valve-mask). Descriptive analyses were completed for patient, provider, and alternative airway device variables. The frequencies of achieving a good view (Cormack-Lehane score [CLS]  $\leq 2$ ) during failed VL attempts were compared between VL devices using a chi-square

test. Chi-square was also used to compare the CLS achieved during direct laryngoscopy (DL) with the CLS achieved during failed VL management. **Results.** Between October 2011 and August 2012, there were 31 failed VL placements in the 94 patients treated. There were no significant demographic differences in patient or provider characteristics. Providers experienced more failures with the KV device than with the CMAC (47.5% vs. 21.1%;  $p < 0.006$ ). The vast majority of the 31 VL failures were managed with DL (84%). The combined DL success rate was high (88.4%), and did not differ statistically between treatment group (CMAC = 77.7%, KV = 94.1%;  $p = 0.24$ ). A good view was achieved in 53% of the total VL placement attempts (CMAC = 64%, KV = 45.5%;  $p = 0.15$ ). When the providers moved to DL, 64% of the total attempts had a good view (CMAC = 46%, KV = 68%,  $p = 0.20$ ). There was no significant difference in achieving a good view between VL and DL ( $p = 0.40$ ). **Conclusion.** Patients who failed VL were most frequently managed by DL, and managed successfully. CMAC offered a better but not statistically better view than KV. When providers moved from CMAC to DL, they reported a worse view, but it did not impact success rate. When providers moved from KV to DL, they reported a better view, raising major concern about the device as a prehospital VL.

**59. DERIVATION OF A PREHOSPITAL DIFFICULT AIRWAY IDENTIFICATION TOOL: THE PREDAIT STUDY**

**Jestin Carlson, Francis Guyette, David Hostler, Mark Pinchalk, Christian Martin-Gill, Saint Vincent Health Center**

**Background.** Endotracheal intubation (ETI) in the prehospital setting is a challenging skill with variable success rates. Several models are available to predict a difficult airway in the hospital, but there are few options for predicting a difficult airway in the field. We sought to derive a model for predicting a difficult airway in the prehospital setting. **Methods.** We prospectively collected data on airway management using an electronic data-collection form that was automatically generated for all cases of airway intervention as part of the patient care record (emsCharts, Pittsburgh, PA). Eighteen data elements were derived from previous studies of ETI and included patient demographics, circumstances surrounding the ETI attempt, methods used, and difficulties encountered (emesis, cervical collar placement, trauma to the neck, etc.). Our primary outcome was first-pass success, defined as successfully passing the endotracheal tube through the vocal cords during the first placement of the laryngoscope into the oral cavity. We used logistic regression to derive a multivariate model to predict a difficult prehospital airway, defined as >1 attempt required to secure the airway. **Results.** We collected data from 16 EMS agencies over 18 months, which included 477 cases where airway intervention was performed. First-pass success occurred in 208 of 367 cases (57%) of ETI. Variables with  $p$ -values <0.1 were included in the multivariate model: inability to manipulate the neck (odds ratio [OR] 0.42; confidence interval [CI] 0.18–0.94;  $p = 0.036$ ), emesis (OR 0.48; CI 0.29–0.77;  $p = 0.002$ ), and inability to palpate landmarks of the neck (OR 0.37; CI 0.14–1;  $p = 0.057$ ). This three-variable model had good fit (Hosmer-Lemeshow = 0.55) with adequate discrimination (area under the receiver-operating curve = 0.78). **Conclusions.** We have derived a simple model to predict a difficult airway (those requiring >1 ETI attempt)

prior to attempting ETI in the prehospital setting, including inability to manipulate the neck, emesis, and inability to palpate landmarks of the neck. While further study will be needed to validate this model, providers encountering these patients should consider using alternate techniques or devices to improve first-pass airway placement.

**60. COMPARATIVE STUDY OF THE EFFECTIVENESS OF THE INTRAORAL MASK VERSUS TRADITIONAL BAG-VALVE-MASK VENTILATION IN A LIGHTLY EMBALMED CADAVER MODEL**

**Richard Walker, Darcy Thompson, M. Hallbeck, Carol Lomneth, Bernadette McCrory, Bethany Lowndes, Lina Lander, Michael Luethge, Michael Miller, William Raynovich, Michael Wadman, UNMC**

**Background.** Bag-valve-mask (BVM) ventilation is more effective using a two-person technique. A novel intraoral mask (IOM) (NuMask®) may allow effective BVM ventilation with a one-person technique. The objective of this study was to compare standard BVM ventilation with the IOM measuring delivered tidal volumes, leakages, and minute ventilations provided. **Methods.** This was a prospective, randomized, nonblinded trial using a lightly embalmed cadaver. The prewarmed cadaver was intubated and attached to a ventilator. Lungs were expanded using increasing peak end-expiratory pressure (PEEP) until breath sounds could be heard bilaterally in the bases along the anterior axillary line, after which the cadaver was extubated. Subjects were randomly assigned to either the IOM or the BVM. Subjects watched a brief instructional video and were permitted to ask questions on the use and technique of each mask. The masks were connected to the ventilator and the participants were asked to maintain a seal with the nondominant hand for 2 minutes. The ventilator delivered 20 breaths at three different set tidal volumes of 500, 750, and 1,000 mL, with a 1-minute rest between each set tidal volume. The minute ventilation, tidal volume delivered (TVi), and tidal volume received (TVo) were recorded for every breath. Leakage (in percentage) was calculated for each breath using the formula  $leak = TVo / TVi$ . **Results.** The 27 subjects conducted over 3,204 ventilations. The TVo at the respective set tidal volumes of 500, 750, and 1,000 mL for the BVM compared with the IOM was 61 versus 301 mL ( $p < 0.001$ ), 140 versus 498 mL ( $p < 0.001$ ), and 304 versus 647 mL ( $p < 0.001$ ). The leakage at the respective volumes for the BVM compared with the IOM was 88% versus 38% ( $p < 0.001$ ), 81% versus 32% ( $p < 0.001$ ), and 66% versus 31% ( $p < 0.001$ ). The minute ventilation at the respective volumes for the BVM compared with the IOM was 0.68 versus 2.89 L/min ( $p < 0.001$ ), 1.37 versus 4.51 L/min ( $p < 0.001$ ), and 2.75 versus 5.99 L/min ( $p < 0.001$ ). **Conclusions.** The intraoral mask (NuMask) was superior to the traditional BVM in received tidal volume, leakage, and minute ventilation at all set tidal volumes in a lightly embalmed cadaver model.

**61. INCIDENCE AND OUTCOMES OF UNRESOLVED PREHOSPITAL REARREST IN EMS-TREATED CASES OF OUT-OF-HOSPITAL CARDIAC ARREST**

**David Salcido, Allison Koller, James Menegazzi, Matthew Sundermann, Clifton Callaway, University of Pittsburgh**

**Background.** The phenomenon of rearrest (RA)—loss of pulses after successful return of spontaneous circulation (ROSC)—is of interest in resuscitation research because even transient loss of pulses prior to hospital arrival may have a detrimental impact on patient out-

comes. Patients who experience RA may also demonstrate specific pathology, the identification and treatment of which may lead to better outcomes. Our objective was to estimate the incidence and outcomes of one manifestation of RA, unresolved prehospital RA (UP-RA), wherein pulses are not reestablished following at least one RA prior to arrival at the emergency department (ED). **Methods.** Case data spanning 2006–2008 were obtained from the Resuscitation Outcomes Consortium, a multisite clinical research consortium with cardiac arrest surveillance programs in 10 sites in North America. Nontraumatic emergency medical services (EMS)-treated cases of out-of-hospital cardiac arrest (OHCA) with any instance of prehospital ROSC were included. Prehospital ROSC events, patient vital status at ED admission, survival to hospital discharge, patient demographics, and ancillary resuscitation variables were ascertained through review of paramedic-generated patient care reports (PCRs), defibrillator data downloads, and hospital records. Prehospital ROSC was defined as a detectible return of pulses resulting in an obvious suspension of cardiopulmonary resuscitation. UP-RA status was assigned to any patient with prehospital ROSC who did not have pulses upon ED arrival. **Results.** Out of 18,937 cases of OHCA across all sites, there were 11,456 (60.5%) EMS-treated cases. Prehospital ROSC was found in 4,609 (40.2%) cases. Of these cases, mean ( $\pm$  standard deviation) patient age was 63.7 ( $\pm 17$ ) years, 37.1% patients were female, 21.5% arrests occurred in public, 13.5% arrests were EMS-witnessed, and overall survival to hospital discharge was 28%. Vital status at the ED was available for 3,116 (67.6%) cases, of which UP-RA was present in 473 (15.2%). Survival was 7.8% in cases with UP-RA, compared with 33.3% in cases without, and UP-RA was directly associated with death prior to hospital discharge (odds ratio: 6.14, confidence interval: 4.31–8.75,  $p < 0.001$ ). **Conclusion.** When characterized as an irreversible event prior to ED arrival, the incidence of RA is relatively uncommon but strongly predictive of nonsurvival at hospital discharge.

**62. LACK OF CORRELATION BETWEEN CHEST COMPRESSION FRACTIONS OVER 0.4 AND SURVIVAL**

**Robert Walker, Tom Brouwer, Fred Chapman, Rudolph Koster, Physio-Control**

**Background.** Chest compression fraction (CCF) is a commonly measured cardiopulmonary resuscitation (CPR) quality metric, but it remains unknown whether there is an optimum CCF. In ventricular fibrillation (VF) patients, one study measured CCF over the first 1–3 minutes and found worse survival for CCFs less than or equal to 0.2 than for higher CCFs. We analyzed a large resuscitation cohort and hypothesized that higher CCF would be associated with increased survival to hospital discharge and good neurologic outcome throughout the range of observed CCFs. **Methods.** In an observational study of prospectively collected data, we enrolled all patients with ventricular tachycardia (VT)/VF out-of-hospital cardiac arrest during calendar year 2009 in five emergency medical services systems. We excluded resuscitations lasting  $< 5$  minutes, and analyzed electrocardiographic and transthoracic impedance recordings to measure CCF over the first 5 minutes (CCF-5) and the entire resuscitation (CCF-all). **Results.** Of 263 patients, 72 patients (27%) survived to discharge, 65 patients (25%) with good neurologic outcome (cerebral performance category 1 or 2). CCF-5 was median (interquartile range) 0.74 (0.63, 0.83), and CCF-all was 0.80 (0.73, 0.85). No cases had a CCF-5 or CCF-all less than or equal to 0.2. For CCF-5 categories

of 0.21–0.40, 0.41–0.60, 0.61–0.80, and 0.81–1.0, survival rates (95% confidence intervals) were 57% (20–88%,  $n = 7$ ), 27% (15–42%,  $n = 45$ ), 24% (18–33%,  $n = 131$ ), and 30% (21–41%,  $n = 80$ ), respectively. Results for CCF-all were similar to results for CCF-5. In a multivariate Utstein-adjusted regression, there were no significant associations between each 0.1 increase in CCF and survival to discharge (CCF-5: odds ratio [OR] = 1.04 [0.83, 1.29]; CCF-all: OR = 0.96 [0.72, 1.28]) or good neurologic outcome (CCF-5: OR = 0.99 [0.79, 1.24]; CCF-all: OR = 0.91 [0.68, 1.22]). **Conclusions.** In this cohort, almost all patients received a chest compression fraction between 0.4 and 1.0, and we found no significant association between increasing CCF and improved outcomes over this range.

**63. MECHANICAL CHEST COMPRESSION AS A BRIDGE TO EXTRACORPOREAL MEMBRANOUS OXYGENATION (ECMO) IN A CLINICALLY REALISTIC PORCINE MODEL OF OUT-OF-HOSPITAL CARDIAC ARREST**

**Joshua Reynolds, David Salcido, Matthew Sunderman, Allison Koller, James Menegazzi, University of Pittsburgh**

**Background.** Extracorporeal membranous oxygenation (ECMO) is an emerging tool in the resuscitation armamentarium. One barrier to implementation in out-of-hospital cardiac arrest (OHCA) is the delay to the initiation of ECMO. Prehospital providers could play key roles in identifying appropriate candidates, maintaining blood flow, and expediting transport to an ECMO-capable center. We evaluated the feasibility of prolonged mechanical chest compression resuscitation followed by ECMO in a porcine model of ventricular fibrillation (VF) utilizing clinically realistic durations of delay to ECMO. **Methods.** We anesthetized and instrumented eight female swine (mean mass 31.9 kg) with 14-French and 18-French catheters via cut-down in the right femoral artery and external jugular vein, respectively. Catheters were flushed with heparinized saline and clamped until initiation of ECMO. After 8 ( $n = 4$ ) or 15 ( $n = 4$ ) minutes of untreated VF, the animals received 30, 40, 50, and 60 minutes of mechanical chest compressions. All animals received drugs (0.6 U/kg vasopressin, 0.1 mg/kg epinephrine, 0.1 mg/kg propranolol) after 5 minutes of cardiopulmonary resuscitation (CPR). ECMO reperfusion was achieved at 3 L/min with a preheparinized centrifugal circuit. activated clotting time (ACT) was maintained above 250 seconds. After 15 minutes of reperfusion with ECMO, the animals were eligible for defibrillation attempts with 150 J based on the electrocardiogram. ECMO flow was 3 L/min for up to two hours and then was reduced to 1.5 L/min for up to two additional hours (four hours total) before weaning. The primary outcome was ROSC, defined as an organized rhythm with systolic blood pressure (SBP)  $> 80$  mmHg; secondary outcomes were one-hour survival on ECMO (SURV) and one-hour survival after weaning off ECMO (WEAN). **Results.** Given as CPR duration in minutes (outcome). For 8 minutes VF: 30 (WEAN), 40 (ROSC), 50 (SURV), 60 (SURV). For 15 minutes VF: 30 (SURV), 40 (no ROSC), 50 (no ROSC), 60 (no ROSC). Animals without ROSC spontaneously converted to an organized rhythm, but had SBPs  $< 80$  mmHg. The most prolonged successful resuscitation occurred one hour 27 minutes after VF onset. **Conclusions.** Mechanical chest compression may be a suitable bridge to ECMO, which may be a feasible resuscitation tool for select OHCA patients. Emergency medical services will play an important role as this technology advances.

**64. SURVIVAL RATES FOR OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS TRANSPORTED WITHOUT A PREHOSPITAL RETURN OF SPONTANEOUS CIRCULATION**

**Ian Drennan, Steve Lin, Daniel Sidalak, Laurie Morrison,**  
*University of Toronto, St. Michael's Hospital*

**Background.** The implementation of the pre-hospital universal termination-of-resuscitation (TOR) guideline (terminate without a prehospital return of spontaneous circulation [ROSC] AND not emergency medical services [EMS]-witnessed AND no shock provided) has reduced the transport rate to hospital. Some services currently use the absence of prehospital ROSC as the single criterion to terminate resuscitation, which may deny transport to potential survivors. Few studies have examined the patient characteristics and prehospital factors associated with survival in OHCA patients transported without a prehospital ROSC. This study aims to describe patient characteristics and prehospital factors associated with survival to hospital discharge in nontraumatic, adult OHCA patients transported to hospital without a prehospital ROSC. **Methods.** This was a retrospective observational study of consecutively treated OHCA patients without a prehospital ROSC who met the universal TOR guideline for transport to hospital with ongoing resuscitation. Bivariate analyses were used to determine associations of patient characteristics and prehospital variables with survival. **Results.** There were 19,571 OHCA patients treated by EMS, of whom 3,208 (16.4%) did not have a prehospital ROSC but met the universal TOR guidelines for transport to hospital with ongoing resuscitation (68.8% shocked, 25.2% EMS-witnessed, 6.0% both). Of these patients, 62 (1.9%) survived to hospital discharge. Survivors were younger (55.6 yr  $\pm$  15.1 vs. 65.4 yr  $\pm$  15.6,  $p < 0.01$ ), had initial shockable rhythms (75.4% vs. 52.6%,  $p < 0.01$ ), had no advanced airway (53.6% vs. 79.2%,  $p < 0.01$ ), and were transported to academic hospitals (30.7% vs. 17.6%,  $p = 0.01$ ). No differences were noted in male gender (71.0% vs. 74.0%,  $p = 0.56$ ), bystander-witnessed arrests (38.7% vs. 42.7%,  $p = 0.17$ ), public location (36.1% vs. 28.7%,  $p = 0.25$ ), bystander cardiopulmonary resuscitation (47.2% vs. 42.8%,  $p = 0.60$ ), EMS response (6.5 min  $\pm$  3.3 vs. 6.8 min  $\pm$  3.5,  $p = 0.47$ ), or advanced life support provider (71.0% vs. 79.7%,  $p = 0.11$ ). **Conclusion.** In OHCA patients without a prehospital ROSC who met the universal TOR guideline for transport with ongoing resuscitation, 2% survived to hospital discharge. This rate of survival is higher than that defined as medically futile (<1%) and suggests that termination of resuscitation should not be based on the absence of prehospital ROSC alone. Survival was associated with younger age, initial shockable rhythms, no advanced airway, and academic hospitals.

**65. TRANSFER OF PATIENTS WITH ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION FOR PRIMARY PERCUTANEOUS CORONARY INTERVENTION (PRIMARY PCI): IDENTIFYING SOURCES OF DELAY IN THE FIRST HOSPITAL CENTER**

**Kevin Brown, Eli Segal, Laurie Lambert, Céline Carroll, Dave Ross, Sébastien Maire, Lucy Boothroyd, Peter Bogaty,**  
*Institut National d'Excellence en Santé et en Services Sociaux*

**Introduction.** Patients with ST-segment elevation myocardial infarction (STEMI) who present to a center without capability to perform primary percutaneous coronary interven-

tion (PCI) as reperfusion treatment and are then transferred to a PCI center rarely achieve the timely benchmark standard of a first "door-in to door-out" (DIDO) interval <30 minutes. Our objective was to characterize the factors associated with DIDO delay using data from a provincewide STEMI field evaluation. **Methods.** Medical chart data of STEMI patients who underwent interhospital transfer for primary PCI were linked to the provincial emergency care database. Using these two data sources, we recorded seven relevant time points: initial triage (door-in time), first electrocardiogram (ECG), transfer activation, arrival of ambulance, departure of ambulance from initial center (door-out time), arrival of ambulance at PCI center, and time of primary PCI. Median times with interquartile range (IQR) were measured. Two coordinating center cardiologists reviewed all presenting ECGs. **Results.** We identified 990 interhospital transfers, of which 745 (75%) could be linked to the emergency care database. Time from first center triage to primary PCI was 111 minutes (IQR: 91–146); DIDO time was 50 (IQR: 35–79). Only 17.2% of patients had a DIDO delay <30 minutes. Time from triage to first ECG was 7 minutes (IQR: 2–15); from first ECG to transfer activation, 21 minutes (IQR: 13–42); and from ambulance arrival to departure, 15 minutes (IQR: 11–19). Transport time was 27 minutes (IQR: 16–44). Median DIDO was shorter in patients transported to the first center by ambulance (45 versus 56 min,  $p < 0.001$ ), especially when the same ambulance was used for patient transfer (38 versus 52 min,  $p < 0.001$ ). Older age, female gender, left bundle branch block, unclear STEMI (cardiologist disagreement on the presence of STEMI), and presentation outside working hours and on weekends were associated with longer DIDO times. **Conclusions.** Benchmark DIDO delays for transferred STEMI patients in Quebec are rarely achieved. Time from ECG to transfer activation and from ambulance arrival to departure were major contributors to DIDO delay. For patients arriving at the initial center by ambulance, use of the same ambulance for transfer was associated with shorter DIDO delay. These findings identify where there is the most potential to reduce DIDO delays.

**66. AMBULANCE USE VERSUS NONUSE IN PATIENTS WITH ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION: A POWERFUL PROGNOSTICATOR OF MORTALITY RISK**

**Lucy Boothroyd, Yongling Xiao, Laurie Lambert, Eli Segal, Dave Ross, Sébastien Maire, Peter Bogaty,**  
*Institut National d'Excellence en Santé et en Services Sociaux*

**Background.** In a Canadian provincewide systematic evaluation of care of patients with ST-segment elevation myocardial infarction (STEMI), we compared the characteristics and survival of ambulance users and nonusers. **Methods.** All 82 acute care Quebec hospitals that treated at least 30 acute myocardial infarctions (AMIs) participated in a six-month evaluation in 2008–2009. Medical record librarians abstracted hospital chart data for AMI patients who presented to the emergency room (ER) with acute symptoms. STEMI was confirmed by core laboratory interpretation of the first electrocardiogram (ECG). Linkage to vital statistics and hospital discharge databases provided data on survival and on diagnoses in the previous five years, respectively. **Results.** Of 1,957 STEMI patients, 1,222 (62%) arrived by ambulance. Compared with nonusers, ambulance users were significantly older, more likely to be female, and more likely to have previous myocardial infarction, peripheral vas-

cular disease, heart failure, hypertension, arrhythmia, renal disease, and chronic obstructive pulmonary disease. At first medical contact, ambulance users were more likely to have low systolic pressure (<90 mmHg), abnormal heart rate (<60 or >100 beats/min), and higher Thrombolysis In Myocardial Infarction (TIMI) risk index. Ambulance users had shorter delays between 1) symptom onset and ER arrival; 2) ER arrival and first ECG; and 3) ER arrival and reperfusion treatment (thrombolysis or primary coronary intervention [PCI]). The proportion receiving thrombolysis or sent for PCI within four hours was lower in the ambulance group (78% vs. 83%;  $p = 0.01$ ). Mortality (in-hospital, 30 days, 1 year) was higher for ambulance users (9.1%, 12.6%, 18.7%, respectively) than nonusers (2.9%, 3.8%, 7.1%, respectively;  $p < 0.001$  for all). Higher mortality persisted (hazard ratio [HR] = 1.5 [95% confidence interval (CI): 1.3–1.8]) after adjusting for gender, anterior AMI, TIMI risk index (which includes age), comorbidities, whether the patient received thrombolysis or was sent for PCI within four hours or not, and the symptoms-to-ER delay (within 3 hours vs. >3 hours). Results were similar when only treated patients ( $N = 1,570$ ) were analyzed and timeliness of reperfusion was included (HR = 1.5 [95% CI: 1.0–2.4]). **Conclusions.** In this provincewide evaluation, ambulance users with STEMI were older and sicker than nonusers. Despite faster reperfusion treatment overall, their mortality was higher. Ambulance use is a simple and powerful marker of mortality in patients with STEMI.

**67. PREHOSPITAL ADMINISTRATION OF MULTIPLE SIMULTANEOUS NITROGLYCERINE SUBLINGUAL TABS RARELY CAUSES HYPOTENSION**

**Brian Clemency, Gina Tundo, Jeffrey Thompson, Heather Lindstrom,**  
*University at Buffalo, State University of New York*

**Background.** High-dose intravenous nitroglycerin is a common in-hospital treatment for respiratory distress due to congestive heart failure (CHF) with hypertension. Intravenous nitroglycerin administration is impractical in the prehospital setting. In 2011, a new regional emergency medical services (EMS) protocol was introduced allowing advanced providers to treat CHF with oral nitroglycerin. Patients were treated with two sublingual tabs (0.8 mg) when systolic blood pressure (SBP) was >160 mmHg or three sublingual tabs (1.2 mg) when SBP was >200 mmHg every 5 minutes as needed. To assess the protocol's safety, we studied the incidence of hypotension following prehospital administration of multiple simultaneous nitroglycerin (MSN) tabs by EMS providers. **Methods.** A retrospective case review of records from a single commercial EMS agency over a six-month period (January–June 2012). Cases with at least one administration of MSN were reviewed. For each administration, the first documented vital signs before and after administration were compared. Administrations were excluded if they were missing pre- or postadministration vital signs. Blood pressure was measured in mmHg. **Results.** One hundred cases had at least one MSN administration by an advanced provider during the study period. Twenty-five cases were excluded because of incomplete vital signs. Seventy-five cases with 95 individual MSN administrations were included for analysis. There were 65 administrations of two tabs, 29 administrations of three tabs, and one administration of four tabs. The mean change in SBP following MSN was -14.7 (standard deviation 30.7; range +59 to -132). Three administrations had documented

systolic hypotension in the postadministration vital signs (97/71, 78/50, and 66/47 mmHg). All three patients were over 65 years old, were administered two tabs, had documented improved respiratory status, and had repeat SBP of at least 100 mmHg. The incidence of hypotension following MSN administration was 3.2%. **Conclusion.** Hypotension was rare and self-limited in this sample of prehospital patients receiving MSN.

#### 68. THE INCIDENCE AND CHARACTER OF STROKE MIMICS IN PATIENTS FLOWN TO A TERTIARY STROKE CENTER

Laura Thompson, Seth Ritter, Christian Martin-Gill, Francis Guyette, University of Pittsburgh

**Background.** Rapid clinical diagnosis of stroke is challenging for physicians and prehospital providers alike. However, identification and treatment of stroke followed by rapid transfer of patients to a stroke center are necessary to improve morbidity and mortality. The aim was to describe the incidence and character of conditions that mimic stroke in a population of patients transported by a helicopter emergency medical service. **Methods.** We conducted a retrospective chart review of patients who were transferred using a regional critical care transport to an academic medical center with a stroke team. We included patients transported with a presumed diagnosis of stroke from 2007 to 2010. We performed probabilistic linkage to associate prehospital records with inpatient data to compare patients diagnosed with stroke syndromes vs. those who were diagnosed with conditions that mimic stroke. **Results.** A total of 1,439 patients were determined to have stroke-like symptoms by prehospital providers using the Cincinnati Stroke Scale. The average age for our study group was 63.9 years, and the study included 51% men. Of 1,439 subjects, 1,082 (75%, confidence interval [CI] 73–77%) were diagnosed with cerebrovascular accident (888, 62%; CI 59–65%), hemorrhagic stroke (57, 4%; CI 3–5%), or transient ischemic attack (137, 10%; CI 8–12%). These patients were excluded from the mimic analysis. We were unable to match or obtain discharge diagnoses on 26 patient charts. A total of 332 patients with stroke mimics were analyzed in our final analysis. Among stroke mimics, the most common diagnoses overall were seizure (86, 26%; CI 21–30%), headache (43, 13%; CI 9–17%), and brain tumor (21, 6%; CI 3–9%). Hypoglycemia (10, 3%; CI 1–5%) and intoxication (7, 2%; CI 0.5–4%) were rare mimics of stroke in this population. **Conclusion.** Stroke mimic diagnoses were widely varied among this population. Many of the patients with mimics required advanced care, and the current system of triage to air did not result in significant overtriage. The most common stroke mimics were seizure, tumor, and headache.

#### 69. CHARACTERISTICS OF NONTRAUMA SCENE FLIGHTS FOR AIR MEDICAL TRANSPORT

Margaret Glantz, Erica Fletcher, Howard Werman, Lara McKenzie, Ohio State University

**Background.** While there is a substantial body of literature on the use of direct scene response to trauma by air medical services, little is known about the use of air medical transportation for patients with nontraumatic medical emergencies. This study describes the practices of air medical transport programs with respect to nontrauma scene responses in several distinct geographic areas throughout the United States and Canada. **Methods.** A descriptive, retrospective study was conducted utilizing data from five air medical transport programs.

Flight information and patient demographic data were collected for all nontrauma scene flights from 2008 to 2010. Descriptive statistics were used to examine indications for transport, Glasgow Coma Scale score (GCS) during transport, and loaded miles traveled. **Results.** A total of 1,785 nontrauma scene flights were evaluated. The percentage of nontrauma flights varied between programs from 0% to 43.6% of scene transports. The most common indication for transport was cardiac, non-ST-segment elevation myocardial infarction, which was seen in 22.9% of medical transports, followed by general medical (15.8%) and neurologic/stroke (11.7%). Cardiac arrest was the primary indication for transport in only 2.5% of flights. A single program reported a large percentage of neurologic/stroke calls (49.4%). The majority of cases where a GCS was recorded had a score of 15 (74.4%). Medical scene flights included in this study ranged from 0 to 680 miles, with a mean ( $\pm$  standard deviation) flight distance of 43.4 ( $\pm$  0.96) miles and a median (interquartile range) of 35.0 (22.0) miles. **Conclusion.** The use of air medical transport for nontraumatic emergencies varies considerably between air transport programs and regions. Differences in the geographic and economic diversity of a region may affect the number and type of nontrauma air medical transports that take place. This study was limited in that only five programs were included; these were not necessarily representative of all the geographic differences that exist throughout the United States and Canada. Future research is needed to determine which nontraumatic emergencies benefit from air transportation from the scene. Furthermore, national guidelines defining the appropriate use of air medical transportation for nontraumatic scene responses are needed.

#### 70. ASSESSING THE VALIDITY OF THE CINCINNATI PREHOSPITAL STROKE SCALE AND THE MEDIC PREHOSPITAL ASSESSMENT FOR CODE STROKE IN AN URBAN EMERGENCY MEDICAL SERVICES AGENCY

Jonathan Studnek, Steve Vandeventer, Doug Swanson, Andrew Asimos, Jodi Dodds, Mecklenburg EMS Agency

**Background.** This study assessed the effectiveness of two prehospital stroke screens in correctly classifying patients suspected of having a stroke. Secondly, the study assessed differences in the sensitivity and specificity of the two screening tools. **Methods.** This retrospective assessment of the Cincinnati Prehospital Stroke Screen (CPSS) and the Medic Prehospital Assessment for Code Stroke (Med PACS) occurred between March 1, 2011, and September 30, 2011, in a single emergency medical services (EMS) agency with seven local hospitals, all classified as stroke-capable. Data were obtained from EMS electronic patient care reports and Get With The Guidelines<sup>®</sup>-Stroke (GWTG-S) registries maintained by the local health care systems. Med PACS was developed specifically for the EMS agency under study by a local team of neurologists, emergency physicians, and paramedics. All physical assessment elements of the CPSS were included in Med PACS; items related to patient history were utilized from the Los Angeles Prehospital Stroke Screen. Additionally, gaze and leg motor functions were included in Med PACS. Patients were classified as CPSS-positive or -negative and Med PACS-positive or -negative if any one of the physical assessment findings was present and patient outcome was determined from the GWTG-S registry. Sensitivity and specificity with resultant 95% confidence intervals were calculated, and McNemar's chi-square analysis was used to assess differences in performance. **Results.** There

were 416 patients enrolled in this study, with 186 (44.7%) diagnosed with a stroke. Med PACS screen classified 293 (70.4%) patients as having an acute stroke, while CPSS classified 322 (77.4%) patients as having an acute stroke. Med PACS scale demonstrated a sensitivity of 0.742 (95% confidence interval [CI] 0.672–0.802) versus 0.790 (95% CI 0.723–0.845) for CPSS. The sensitivity of CPSS was significantly higher than that of Med PACS, with a difference of 0.048 (95% CI 0.009–0.088;  $p = 0.011$ ). The specificities of these two scales were low: Med PACS 0.326 (95% CI 0.267–0.391) versus CPSS 0.239 (95% CI 0.187–0.300), with the specificity of Med PACS significantly higher compared with CPSS, with a difference of 0.086 (95% CI 0.042–0.131;  $p < 0.001$ ). **Conclusions.** The results of this study demonstrated no superiority between the two scales, with each scale performing marginally better in one of the metrics assessed.

#### 71. OFF-DUTY SLEEP DISRUPTION NEGATIVELY IMPACTS BEHAVIORAL HEALTH IN PARAMEDICS

Marc Kruse, Jose Cabanas, Teresa Gardner, Jeffrey Hayes, Paul Parrish, Louis Gonzales, Paul Hinchey, Austin Fire Department & Austin-Travis County EMS

**Background.** In spite of increased awareness of the effects of sleep deprivation on job performance in emergency medical services (EMS) providers, the impact of off-duty sleep habits is not well understood. The goal of the current study was to describe the off-duty sleep patterns of paramedics and these patterns' association with behavioral health. **Methods.** An anonymous, voluntary, cross-sectional survey was conducted during scheduled continuing education sessions at a large third-service EMS agency. In addition to providing demographic and off-duty sleep data, the participants completed the Beck Depression Inventory-II, PTSD Checklist, Brief Resilience Scale, Sources of Occupational Stress Scale, Professional Quality of Life Scale, Brief COPE, and measures of alcohol consumption and life satisfaction. **Results.** Of the 320 eligible paramedics, 256 completed the survey (80% response rate; 81% male; 82% non-Hispanic Caucasian). Even though on-duty sleep disruption was identified as the greatest source of occupational stress, the paramedics reported off-duty sleep for an average of only 6.3 hours (standard deviation [SD] = 1.5; range 3–12). Analysis of variance (ANOVA) revealed a significant association between depression symptoms and off-duty sleep. Those paramedics reporting no/minimal (53.8%), mild (20.7%), moderate (19.9%), and severe (5.6%) depression symptoms reported average sleep of 6.6 (SD = 1.4), 6.2 (SD = 1.2), 5.9 (SD = 1.4), and 5.5 (SD = 2.3) hours, respectively,  $F(3, 243) = 5.08$ ,  $p = 0.002$ . A series of hierarchical linear regressions also demonstrated that after controlling for gender, race/ethnicity, years of EMS experience, and hours worked, reduced off-duty sleep was significantly associated with higher posttraumatic stress disorder (PTSD) symptoms ( $p < 0.001$ ), lower life satisfaction ( $p < 0.001$ ), lower psychological resilience ( $p = 0.004$ ), higher occupational stress ( $p = 0.004$ ), higher burnout ( $p = 0.006$ ), more frequent drinking to intoxication ( $p = 0.022$ ), and poorer coping strategies, including behavioral disengagement ( $p = 0.002$ ), using substances ( $p = 0.002$ ), and using food ( $p = 0.026$ ) to deal with stress. **Conclusions.** The findings from this cross-sectional study demonstrate a strong association between off-duty sleep disruption and behavioral health in paramedics and suggest that EMS providers might benefit from interventions designed to improve sleep quantity and quality.

## 72. THE EPIDEMIOLOGY OF NEEDLE DECOMPRESSION IN A LARGE URBAN EMS SYSTEM

Michael Redlener, David Ben-Eli, Daniel Goldberg, Robert Silverman, Pamela Lai, Bradley Kaufman, Douglas Isaacs, James Braun, John Freese,  
St. Luke's-Roosevelt Medical Center

**Background.** To describe the utilization of needle decompression (ND) for suspected tension pneumothorax in a large urban emergency medical services (EMS) system. **Methods.** Retrospective chart review and case series of all NDs performed by a municipal ambulance service from January 1, 2007, to December 31, 2011. Call type, category of clinical presentation, trauma versus nontrauma, cardiac arrest status, evidence of clinical improvement, and on-scene and transport times were collected. **Results.** Over the study period, 140 NDs were performed. A total of 99 (71%) NDs were during trauma calls (78 [55.7%] penetrating trauma, 21 [15%] blunt trauma) and 41 (29%) were during medical calls (22 [15.7%] in medical arrests, three [2.1%] had spontaneous pneumothorax, five [3.6%] had an iatrogenic cause, and 11 [7.9%] had an unknown cause). Thirty (21%) of the overall patients were female. The overall median age was 42 years. The median age of patients in the trauma group was 26 years and in the medical group was 72.5 years ( $p < 0.01$ ). A total of 69 (49.3%) experienced cardiopulmonary arrest prior to or during the EMS call (36/69 in trauma, 33/69 in medical group), five achieving return of spontaneous circulation (ROSC) after ND, with four maintaining ROSC until emergency department admission. All ROSCs occurred in medical arrest patients. Of the 71 patients who did not experience cardiac arrest, 51 (71.8%) were found to have clinical improvement by 1) return of the trachea to midline, 2) return of lung sounds to the affected side, 3) patient report of relief, and/or 4) improvement in systolic blood pressure and/or pulse rate. In the trauma group, 63 (63.6%) of the patients did not have cardiac arrest; of those patients, 45 of 63 (71.4%) experienced clinical improvement. In the medical group, of the eight patients who did not experience arrest, six (75%) of the patients experienced clinical improvement. **Conclusions.** In this large urban EMS system, ND appeared to primarily benefit trauma patients who were not in cardiac arrest. Early identification and use of needle decompression in patients with trauma-related pneumothorax should be encouraged. These retrospective data also suggest that needle decompression may have a role in appropriate medical scenarios, including cardiac arrest.

## 73. BARRIERS, FACILITATORS, RECOMMENDATIONS, AND PRIORITIES FOR EMS RESEARCH: A SCOPING REVIEW OF RESEARCH AGENDAS

Ian Blanchard, Ryan Brown, Jan Jensen, Blair Bigham, Alix Carter, Andrew Travers, Laurie Morrison, University of Calgary

**Background.** Several countries and organizations have created a research agenda in an effort to improve and focus the emergency medical services (EMS) research enterprise. To date, results from these agendas have not been compiled, which may hinder knowledge translation. Scoping reviews are used to map broad topics and summarize and disseminate research findings. The purpose of this study was to map reported research agenda methods, the barriers and facilitators to EMS research, the recommendations made, and the prioritization

of research topics and outcomes. **Methods.** A combination of Medical Subject Headings and key words was used to search Medline, EMBASE, CINAHL, Google Scholar, and the grey literature using Google with no date restrictions. Search results were subject to two review rounds for inclusion: 1) title, Web-link, and abstract and 2) full article screening. Articles were included if they were a "research agenda," defined as a knowledge-generating project where a group of national stakeholders in EMS research reached consensus on at least one of the following: barriers, facilitators, recommendations, or prioritization of research topics and outcomes. Non-English-language articles were excluded. **Results.** Three thousand six hundred eighteen titles, Web-links, and abstracts and 52 full-text articles were reviewed. Ten distinct EMS research agendas reported in 17 articles were included; 13 articles from peer-reviewed journals and four from non-peer-reviewed sources. Agendas from Australia ( $n = 1$ ), Canada ( $n = 1$ ), Europe ( $n = 1$ ), Ireland ( $n = 1$ ), the United Kingdom ( $n = 1$ ), and the United States ( $n = 5$ ) used 13 unique methodologies to report 22 barriers and five facilitators to EMS research. Agendas proffered 46 recommendations for improving the research enterprise with some setting-specific implementation strategies, and 217 prioritized topics and outcomes. **Conclusions.** Multiple EMS research agendas were identified employing a variety of methods and revealing many barriers, recommendations, and priority research topics and outcomes, but few reported facilitators. While some of the results are setting-specific, there were numerous similarities between the agendas. Translation of the results of these agendas at the local level may be a starting point for actionable changes to the EMS research enterprise. Future research should quantify the impact that these agendas have had on improving the quality, quantity, and usefulness of EMS research.

## 74. THE MASSACHUSETTS EMERGENCY MEDICAL SERVICE STROKE QUALITY IMPROVEMENT COLLABORATIVE

Denise Daudelin, Erin Kulick, Jennifer Donovan, Mirian Barrientos, Katrina D'Amore, Robin Ruthazer, Kathy Foell,  
Tufts Medical Center/Tufts Medical School

**Background.** Quality improvement collaboratives (QICs) are a popular approach addressing gaps between evidence-based practices and actual patient care. Little is known about their use in emergency medical services (EMS), particularly to improve prehospital stroke care. Despite EMS's important role in the stroke system of care, no nationally recognized EMS stroke performance measures exist. We created a prehospital stroke care QIC involving Massachusetts EMS agencies. Our objective was to determine the feasibility of using a stroke QIC to improve EMS stroke care. **Methods.** A QIC was conducted with 16 EMS agencies. Five prehospital stroke performance measures were developed to quantify the quality of prehospital care, guide QIC activities, and monitor change in performance over time. During learning sessions, participants trained in QI and performance measurement collected and analyzed performance measure results and shared successes and challenges. Focus groups were conducted to understand participants' experiences with the collaborative. Mixed-model logistic regression was used to compare the changes in the five measures over time. **Results.** Participating EMS agencies collected stroke performance measures on 2,272 patients. Adherence to four of the five performance measures increased significantly overall as well as between

the first and the last three months of participation. Patients with a clinical impression of stroke had a high rate of formal stroke screening performed; from the first three months to the final three months the rate increased from 94% to 96% ( $p = 0.32$ ). Blood glucose testing increased from 92% to 99% ( $p = 0.0002$ ). Documentation of the patient's time last known to be well increased from 79% to 95% ( $p = 0.0001$ ). Time of stroke symptom discovery documentation increased from 85% to 96% ( $p = 0.0004$ ). Hospital prenotification of suspected stroke increased from 60% to 90% ( $p = 0.0001$ ). Participants acknowledged that the QIC provided them with an efficient and effective framework for stroke QI and peer-learning opportunities. **Conclusions.** As evidenced through the Massachusetts prehospital stroke QI collaborative experience, QICs can be an effective tool to improve EMS stroke care. The data collected, improvements made, participation of EMS agencies, and positive experiences with the collaborative support the continued use of this approach.

## 75. IMPLEMENTATION OF PREHOSPITAL DISPATCH PROTOCOLS TO TRIAGE LOW-ACUITY PATIENTS TO ADVISE LINE NURSES

Allison Infinger, Jonathan Studnek, Steve Vandeverter, Eric Hawkins, Doug Swanson,  
Mecklenburg EMS Agency

**Background.** Although emergency medical services (EMS) agencies have been designed to efficiently provide medical assistance to individuals, the overuse of 9-1-1 as an alternate to primary medical care has resulted in the need for methods to respond to this increasing demand. This study analyzes the efficacy of classifying specific low-acuity calls that can be transferred to an advice line nurse for further medical instruction. The objectives of this study were to analyze the impact of implementing this protocol and resultant patient satisfaction with the transfer to an advice line nurse. **Methods.** We collected data for retrospective review from April 2011 to April 2012 from a single municipal EMS agency with an average annual call volume of approximately 90,000. Medical Priority Dispatch System response codes were assigned to calls based on patient acuity. Patients classified under Omega response codes were assessed for eligibility of transfer to nurse advice lines. Exclusion criteria included the following: if the call was placed by a third-party caller; the patient refused to be transferred to the advice line nurse; anytime the MPDS system was not used; or the patient was referred from a skilled nursing facility, school or university nursing office, or physician's office. Telephone surveys were conducted for those patients who spoke to an advice line nurse and did not receive an ambulance response 24 hours after calling 9-1-1 to determine patient satisfaction. **Results.** The database included 1,660 patients initially classified as Omega and eligible for transfer to an advice line nurse. After applying the exclusion criteria, 329 (19.8%) patients were ultimately transferred to an advice line nurse and 204 (12.3%) received no ambulance response. Of those patients who were not transported by ambulance, 118 (57.8%) patients completed telephone follow-up with 104 (88.1%) reporting satisfaction with the nontransport option and 108 (91.5%) responding they would accept the transfer again for a similar complaint. **Conclusion.** We identified an average of two patients per day as eligible for transfer to the advice line nurse, with less than one patient successfully completing the Omega protocol per day. While impact was limited, there was a decrease in ambulance response, with maintenance of patient satisfaction.

## 76. REGIONAL DISTRIBUTION OF PREHOSPITAL PATIENTS AT RISK OF CRITICAL ILLNESS

Adam Frisch, Brian Suffoletto, Christopher Seymour, Chris Martin-Gill, University of Pittsburgh

**Background.** Admission to a hospital with increased volume of intensive care unit (ICU) admissions has been associated with reduced mortality of critically ill patients compared with low-volume hospitals. Calls for improvements in regionalized specialty care have included the preferential transfer of patients at risk of critical illness to high-volume facilities. The current distribution of such patients by emergency medical services (EMS) to high- and low-volume facilities is unknown. **Methods.** We studied an existing cohort of prehospital medical records for patients transported from a scene to an emergency department by 37 local EMS agencies over 12 months. We used American Hospital Association data to stratify the 161 acute care facilities in Pennsylvania based on quartiles of total patient ICU days, with the highest and lowest quartiles identified as high- and low-volume facilities. Data obtained from prehospital medical records included age, vital signs, Glasgow Coma Scale score, and receiving facility. We used a critical illness score (Seymour et al., 2010) to stratify patients based on risk of critical illness (score  $\geq$ ) and identified the proportions of patients transported to high- and low-volume facilities. Missing data were replaced with worst-case scores. **Results.** A total of 50,364 medical records were reviewed. The distribution of critical illness scores was 0 (4,885, 9.7%, 95% confidence interval [CI] 9.4–9.95), 1 (23,946, 47.6%, 47.1–47.9), 2 (12,788, 25.39%, 25.0–25.7), 3 (5,327, 10.67%, 10.4–10.9), 4 (2,265, 4.5%, 4.3–4.6), 5 (830, 1.65%, 1.5–1.8), 6 (230, 0.46%, 0.39–0.51), 7 (44, 0.09%, 0–0.1), and 8 (4, 0.01%). Of 21,533 patients with critical illness score  $\geq$  2, 8,056 (37.4%, 95% CI 36.8–38.1) were transported to high-volume facilities and 870 (4.0%, 3.7–4.3) to low-volume facilities ( $p < 0.05$ ). 12,607 patients (58.5%, 57.9–59.2) were transported to other facilities. **Conclusions.** Many patients at high risk for critical illness are transported to high-volume facilities, but the majority are transported to other facilities and a small percentage of these patients are transported to low-volume facilities. By identifying patients with high critical illness scores in the prehospital setting, there is potential that EMS could initiate transport of these patients to a facility that is more experienced in the care of the critically ill.

## 77. PREVALENCE OF CERVICAL SPINE FRACTURES AMONG ELDERLY PATIENTS WHO SUFFER HIP FRACTURES DURING LOW-LEVEL FALLS: AN OPPORTUNITY TO REFINEMENT PREHOSPITAL SPINAL IMMOBILIZATION GUIDELINES

Paul Satterlee, Lori Boland, Paul Jansen, Allina Health EMS

**Background.** Conventional emergency medical services (EMS) spine-assessment approaches based on low index of suspicion and mechanism of injury (MOI) result in the liberal application of prehospital spinal immobilization in trauma patients. Since EMS protocols often designate the presence of a distracting injury as a sufficient condition for immobilization, a painful hip fracture often obligates immobilization, even in an elderly patient who suffers from a simple fall from standing and has no apparent neurologic deficit or cervical tenderness. To inform further refinement of spine-assessment protocols, we examined the prevalence of cervical spine fractures (CSFs) in

elderly patients with hip fracture from a fall from standing height or less. **Methods.** Billing records of inpatient and outpatient discharges from hospitals in Minnesota were used to identify all cases of traumatic hip fracture that occurred in Minnesota in 2010. Concurrent diagnosis codes were reviewed and the prevalence of CSF by age and MOI was examined. **Results.** Among 2,747 patients with traumatic hip fractures, only 1.5% ( $n = 40$ ) had a CSF among diagnosis codes for the same admission. The prevalence of CSF was only 0.3% (4/1,346) when the MOI was a same- or low-level fall, and 2.6% when the hip fracture was caused by other traumatic mechanisms (36/1,401;  $p < 0.001$ ). Among the four same- or low-level fall patients with CSF, three were over the age of 65 years, and diagnosis codes indicative of blunt head trauma or altered mental status (e.g., concussion, facial fractures) were found in all four patients. **Conclusions.** Spinal immobilization is associated with discomfort, pressure sores, and respiratory compromise, particularly in the elderly, and EMS providers continue to refine spine-assessment tools in an effort to limit unnecessary use of this procedure. These cross-sectional data suggest that elderly patients with suspected hip fracture after a fall from standing height or similar rarely suffer CSFs that would require spinal immobilization by prehospital providers, and when CSF does occur in this patient population, it is frequently accompanied by head trauma or altered mentation. Conservative use of spinal immobilization may be warranted in elderly patients who suffer hip fracture during low-level falls when the only criterion for immobilization is the distracting hip injury.

## 78. DETECTING PREHOSPITAL HEMOPERITONEUM REMOTELY THROUGH FOCUSED ASSESSMENT WITH SONOGRAPHY IN TRAUMA (FAST) AND A 3G NETWORK: A SIMULATION STUDY

Ki Jeong Hong, Kyoung Jun Song, Sung Wook Song, Sand Do Shin, National University Boramae Medical Center, Seoul

**Background.** Prehospital focused assessment with sonography in trauma (FAST) is used to diagnose hemoperitoneum and determine whether transportation to a trauma center is necessary. The goal of this study was to simulate detecting prehospital hemoperitoneum remotely through FAST and a 3G network. **Methods.** We developed a real-time image transmission system for prehospital ultrasound. In the system, the ultrasound image is initially acquired using portable sonography (SonoSite Inc., Bothell, WA, USA) and transmitted to the emergency department (ED) through a 3G network. One emergency medical technician (EMT) acquired the prehospital FAST image inside an ambulance. Image acquisition and transmission was conducted at 3, 5, 10, and 15 km from the ED and during migration between these points. At each point, the EMT performed FAST with a hepatorenal view using two phantom models randomly: normal model and hemoperitoneum model. Emergency physicians interpreted the FAST images. We analyzed sensitivity, specificity, and area under the curve (AUC). We also conducted subgroup analysis by grade of emergency physicians (board-certified, senior resident, and junior resident), moving status of the ambulance vehicle, and distance from the ED. **Results.** A total of 17 image acquisitions and transmissions were attempted, with a success rate of 15 of 17 (88.2%). Two board-certified emergency medicine (EM) physicians, four senior residents, and two junior residents were recruited to detect the presence of fluid collection

in the hepatorenal area. The sensitivity, specificity, and AUC value of the emergency physicians overall were 67.9%, 78.1%, and 0.73 (95% confidence interval [CI]: 0.65–0.81), respectively. Results of subgroup analysis of the EM board-certified physicians were 85.7%, 95.8%, and 0.90. Higher-grade emergency physicians showed a significantly higher value for the AUC (board-certified: 0.90, senior resident: 0.69, junior resident: 0.63,  $p = 0.01$ ). There was no significant difference of AUC regarding moving status of ambulance or distance from the ED ( $p = 0.34, 0.98$ ). **Conclusions.** Simulation of detecting hemoperitoneum using prehospital FAST through a 3G network showed acceptable performance. Higher grade of emergency physicians showed better performance.

## 79. PREHOSPITAL INTUBATION RESULTS INCREASES IN PULMONARY INFECTION IN TRAUMATICALLY INJURED PATIENTS

Dug Andrusiek, Danny Szydlo, Martin Schrieber, Karen Brasel, Russell MacDonald, Joseph Minei, Rardi van Heest, Susanne May, Emergency and Health Services Commission

**Background.** Infection is a major cause of morbidity and mortality in multisystem trauma. Sources of infection in trauma are not well understood. The impact of invasive prehospital procedures, including intubation and needle thoracostomy, on the incidence of infection is not known. We hypothesized that trauma patients who are exposed to prehospital intubation and needle thoracostomy will have higher rates of pneumonia and empyema compared with those who have no exposure or exposure to the same procedures performed in the hospital. **Methods.** This was an observational cohort study of data previously collected from the Resuscitation Outcomes Consortium (ROC) hypertonic saline (HS) trial. Patients were included if they were found to have an injury that resulted in shock, traumatic brain injury, or both. Patients were excluded if they had an infection detected or died within the first 24 hours after injury, or if infection data were missing. Descriptive statistics were calculated, and unadjusted and adjusted logistic regression was used to estimate the odds ratio (OR) of having an infection if the patient was exposed in the prehospital setting compared with exposure in the hospital or no exposure. Multivariable models were adjusted for Abbreviated Injury Scale (AIS) score, type of injury, age, and HS treatment group. **Results.** Of 2,222 patients enrolled in the HS group, 1,676 patients met the enrollment criteria. Patients suffered from either pneumonia or empyema 4.5% of the time. Compared with no intubation, intubation in the prehospital setting was associated with a 7.7-fold increase (95% confidence interval [CI] 2.0, 23.0;  $p = 0.003$ ) in the adjusted odds of having pneumonia, while in-hospital intubation was associated with a 4.8-fold increase (95% CI 1.4, 16.6;  $p = 0.01$ ). Compared with no or in-hospital needle thoracostomy, prehospital needle thoracostomy was not associated with a statistically significant increase in empyema or pneumonia (OR 0.34; 95% CI 0.05, 2.05;  $p = 0.29$ ). **Conclusions.** In this study, exposure to intubation in the prehospital setting was associated with an increase in pneumonia, while prehospital exposure to needle thoracostomy was not associated with an increase in empyema. Additional research is needed to determine whether the increased risk of pulmonary infections associated with prehospital intubation is due to prehospital airway intervention or confounded by other factors.

**80. PROVISION OF PREHOSPITAL ANALGESIA TO OLDER FALLERS WITH SUSPECTED FRACTURES: ABOVE PAR, BUT OPPORTUNITIES FOR IMPROVEMENT EXIST**

Paul Simpson, Jason Bendall, Anne Tiedemann, Stephen Lord, Jacqueline Close, Ambulance Service of New South Wales

**Background.** Paramedics frequently attend older patients who have fallen and sustained suspected fractures, a population of patients who may be at risk of inadequate analgesic care. This prospective study aimed to describe the rate and effectiveness of analgesia administered by paramedics to older patients with suspected fractures secondary to falls, and to identify predictive factors associated with the provision of analgesia. **Methods.** A prospective, observational study of patients aged 65 years and older who had fallen was conducted from October 1, 2010, through June 30, 2011. Fall-specific data, collected on scene by paramedics using a specially designed data form, were linked to patient clinical records and dispatch information. Cases in which a patient was diagnosed by paramedics as having a suspected fracture were extracted to form the study population. Descriptive analyses were performed to describe rates and effectiveness of analgesic administration, and multivariate logistic regression was conducted to identify factors associated with the provision of analgesia. **Results.** There were 333 eligible patients identified. The mean age was 82 years (standard deviation [SD] 8), and 75% were female. Suspected fractures of the hip were most common (42%). An initial pain score was recorded in 67% of cases, and the median initial pain severity was 8 (interquartile range [IQR] 5–9). Overall, 60% received analgesia and 80% of those received a parenteral opiate. Intravenous morphine was most commonly administered (63%), followed by methoxyflurane (39%) and intranasal fentanyl (17%). Administration of an oral analgesic was uncommon. Analgesia was effective ( $\geq 30\%$  reduction in initial pain severity) in 62% of cases. Patients with suspected hip fractures were more likely to receive analgesia compared with other sites (odds ratio [OR] 2.7, 95% confidence interval [CI] 1.17–6.32;  $p = 0.02$ ). Compared with those with mild pain, the adjusted odds of receiving analgesia increased for patients with moderate pain (OR 6.5, 95% CI 2.3–18.8;  $p < 0.0001$ ) and severe pain (OR 31.1, 95% CI 9.9–97.6;  $p < 0.0001$ ). **Conclusions.** While two-thirds of older patients with suspected fractures received analgesia, more clinical initiatives are required in order to optimize out-of-hospital pain management. Implementation of pain measurement and assessment strategies specific to older patients, and further exploration of analgesic alternatives such as simple analgesics and regional anesthesia, could optimize out-of-hospital management of traumatic pain in older people.

**81. ANALYSIS OF PREHOSPITAL TREATMENT OF PAIN IN THE MULTISYSTEM TRAUMA PATIENT AT A COMMUNITY LEVEL II TRAUMA CENTER**

Ranko Bulatovic, Paul Bradford, Peter Morassutti, Michael Lowell, Elsie Galbraith, Suzanne McKenzie, Diane Bradford, Shelley McLeod, Michael Peddle, Adam Dukelow, Don Eby, University of Western Ontario

**Background.** The Ontario advanced life support patient care standards (ALS-PCS) limit the delivery of analgesia by advanced care paramedics (ACPs) to trauma patients who have suffered from isolated extremity trauma. However, ACPs are able to establish online

medical control to request analgesia for trauma patients who do not meet the ALS-PCS. The primary objective of this study was to determine how often analgesia is provided to trauma patients as defined by an Injury Severity Score (ISS)  $> 12$  either by the ALS-PCS medical directive or through online medical control. Secondary outcomes included the proportion of patients who were transported by ACPs versus primary care paramedics (PCPs) and the time saved if analgesia was delivered in the field versus in the emergency department (ED). **Methods.** A retrospective chart review of trauma patients transported to a level II trauma center from April 1, 2010, to March 31, 2011, was performed. Interfacility transports, walk-ins, and patients who fell in hospital were excluded. Cases were reviewed by a trained ACP auditor, medical student, and emergency medical services (EMS) trauma team leader physician. **Results.** Two hundred twenty-eight patients with ISS  $> 12$  were reviewed. Seventy-eight were excluded (53 interfacility transports, 23 walk-ins, and two in-hospital falls). Of the remaining 150 patients, 62 (41%) had an ACP response where the potential to provide analgesia existed. Of these 62 patients, only five (8.1%) received prehospital analgesia. The median (interquartile range [IQR]) time to prehospital analgesia was 29 (19, 29) minutes. No patients were covered by the ALS-PCS medical directive and all five patients who received analgesia required online medical control. Of the 57 ACP patients who did not receive prehospital analgesia, 37 (64.9%) were given analgesia in the ED (median [IQR] of 68 [48, 165] minutes). **Conclusions.** Despite demonstrated rapid delivery, the frequency of prehospital analgesia use for multisystem trauma patients is extremely low. The majority are attended by PCPs who cannot administer analgesia. Promoting more frequent use of online medical control by ACPs may allow patients to receive analgesia much sooner. Consideration should be given to expanding prehospital directives for all paramedics to include pain control for multisystem trauma patients.

**82. IMPACT OF A COUNTYWIDE PREHOSPITAL DESTINATION PROTOCOL ON THROMBOLYTIC RATES FOR ACUTE ISCHEMIC STROKE (AIS)**

Prasanthi Govindarajan, David Ghilarducci, Larry Cook, Barbara Grimes, Stephen Shiboski, S. Claiborne Johnston, University of California San Francisco

**Background.** Population-based studies support regionalization of stroke care. **Objectives.** We describe the intravenous (IV) tissue-plasminogen activator (t-PA) rates in ambulance-transported acute ischemic stroke (AIS) patients before and during implementation of a countywide prehospital stroke center destination protocol (SDP) and examine the association between SDP and IV t-PA rates in ambulance-transported AIS patients. **Methods.** This was a cross-sectional observational study of patients with a hospital-based diagnosis of AIS identified using validated *International Classification of Diseases, Ninth Revision* (ICD-9) codes. Patient records from 2005–2007 were obtained from the discharge abstract file of the statewide administrative database and were linked to the prehospital electronic records using patient-level identifiers and probabilistic linkage methodology. Thrombolytic use for AIS was identified using the procedure codes in the discharge database. We excluded direct admissions and interfacility transfers. The IV t-PA rate by year was calculated. Logistic regression was used to determine association between SDP and the

IV t-PA rate in AIS patients after controlling for patient and hospital demographics, stroke center designation and teaching status of the hospital, patient residence, and day of the week using logistic regression. Data analysis was performed using SAS 9.2. **Results.** During a three-year period, 6,181 patients with a primary or secondary diagnosis of stroke were transported by ambulance. The mean age at the time of admission was 74 ( $\pm 15$ ) years; 54% ( $n = 3,312$ ) were female; and 63% ( $n = 3,870$ ) were white. The majority of patients, 4,132 (70%), were treated at stroke centers, and 6,005 (97%) were treated at community hospitals. Among ambulance transports, the IV t-PA rate did not increase during the implementation of the stroke center designation protocol (preprotocol phase 2.82%, postprotocol phase 2.85%,  $p$ -value 0.95). After controlling for patient demographics, stroke center status, teaching status of the hospital, and the weekend effect, SDP implementation was not independently associated with increased rate of IV t-PA in AIS (odds ratio 0.96, 95 confidence interval 0.63–1.47). **Conclusions.** Among ambulance-transported patients, our preliminary findings do not show an increase in thrombolytic rates during implementation of a stroke center destination program.

**83. ARE EMERGENCY MEDICAL SERVICES (EMS) USED FOR EMERGENCY MEDICAL TRANSPORTS? FINDINGS FROM THE NHAMCS EMERGENCY DEPARTMENT DATA FILE ON NATIONAL PATTERNS OF AMBULANCE UTILIZATION (2003–2009)**

Katie Tataris, John Stein, Kristin Kuzma, Renee Hsia, Judith Maselli, Ralph Gonzales, Prasanthi Govindarajan, University of California San Francisco–San Francisco General Hospital

**Background.** Emergency medical services (EMS) transports for medically unnecessary conditions have increased over the years. Our objective was to identify patient and regional characteristics associated with transport by EMS for these noncritical conditions. **Methods.** This was a cross-sectional observational study conducted using the 2003–2009 National Hospital Ambulatory Medical Care Survey (NHAMCS) database. The definition of noncritical condition was based on the Neely consensus conference criteria in which physicians coded the transport decision for each *International Classification of Diseases, Ninth Revision* (ICD-9) code as medically necessary, unnecessary, or uncertain. Majority agreement among physicians determined the transport decision code. Our analysis included medically unnecessary transports in patients  $\geq 18$  years of age who were discharged from the emergency department (ED). The characteristics of EMS transports for noncritical conditions were compared with other modes of transport using descriptive statistics. Logistic regression was used to identify independent predictors of arrival by ambulance to the ED. **Results.** The average proportion of noncritical transports for the study period was 9.4% (actual  $N = 5,160$ , weighted  $N = 16,735,915$ ). Factors independently associated with transports by EMS for noncritical conditions included age, insurance status, geographic location of the ED, urban or rural location of the ED, and patient residence. Older patients were more likely to use ambulances for noncritical conditions (odds ratio [OR] 1.32, 95% confidence interval [CI] 1.28–1.35). Patients with Medicaid had higher odds of ambulance utilization (OR 1.24, 95% CI 1.07–1.43), while those with private

insurance had lower odds of using ambulances (OR 0.74, 95% CI 0.65–0.85). Nursing home residents had a higher odds compared with those transported from other locations (OR 9.43, 95% CI 7.86–11.31). Patients transported to EDs in urban locations had a higher use of ambulances compared with those in rural locations (OR 1.86, 95% CI 1.55–2.22). Patients residing in the South, Midwest, and West had lower odds of ambulance utilization compared with those in the Northeast (OR 0.64, 95% CI 0.52–0.78) (OR 0.64, 95% CI 0.52–0.78) (OR 0.69, 95% CI 0.56–0.84). **Conclusions.** Reducing unnecessary noncritical medical transports by EMS could decrease the burden on overcrowded EDs. Future efforts should attempt to discern patient and organizational factors within nursing homes associated with increased utilization of EMS for noncritical conditions.

#### 84. MODIFICATION AND VALIDATION OF THE BASIC LIFE SUPPORT TERMINATION-OF-RESUSCITATION RULE IN ADULT OUT-OF-HOSPITAL CARDIAC ARREST IN KOREA

TaeHan Kim, Sang Do Shin, Kyoung Jun Song, Chang Bae Park, Eui Jung Lee, Young Sun Ro, Chungju Medical Center, Korea

**Background.** The basic life support termination-of-resuscitation (BLS TOR) rule has been shown to reduce unnecessary use of emergency medical services (EMS) resources. The BLS TOR rule had been validated in several countries and has proven to have high predictive value. East Asian EMS systems are different from those in North America and Europe. All out-of-hospital cardiac arrest (OHCA) patients are transported with receipt of cardiopulmonary resuscitation (CPR) during ambulance transport in these systems. We validated the BLS TOR rule and modified it to fit Korean EMS. **Methods.** We used the OHCA database of the Seoul metropolitan area, composed of hospital and ambulance data, which contained the Utstein risks and hospital outcomes. We included EMS-treated victims who were aged 18 years or older. Cases with presumed noncardiac etiology as well as those without available hospital outcome data were excluded. The primary outcomes were survival to hospital discharge and good neurologic outcome (cerebral performance category 1 to 2). We tested the predictive performance of the TOR rule, calculating sensitivity, specificity, and positive and negative predictive values. We supplemented and tested the decision rule with each response time interval (limit of 10 minutes). **Results.** Of 3,812 OHCA patients, we excluded 1,127 (noncardiac etiology), 72 (younger than 18 years), and 859 (unknown information on witness). A total of 2,127 cases (55.8%) were eligible for the final analysis. After applying the BLS TOR rule, 1,368 (64.3%) patients met all three criteria of the BLS TOR rule. Of these, 109 (8.0%) survived to discharge (sensitivity 69.2%, specificity 64.6%, positive predictive value 92.0%, and negative predictive value 26.2%) and good neurologic outcome (sensitivity 66.7%, specificity 91.8%, positive predictive value 99.6%, and negative predictive value 5.1%). The addition of an additional response time criterion (over 10 minutes) to the original rule appeared to improve the specificity (93.5%). **Conclusions.** The BLS TOR rule showed relatively lower specificities in retrospective validation of Korean OHCA data. However, with the addition of response time intervals, the modified TOR rules showed better predictive performance for different characteristics of Korean EMS and prehospital care.

#### 85. PATIENT-CENTERED PREHOSPITAL CARE—ASSESSMENT OF PATIENT PERSPECTIVES

Kevin Munjal, Daniel Reid, Corita Grudzen, Brandon First, Kelly Silverman, Kevin Chason, Lynne Richardson, Mount Sinai Medical Center

**Background.** There is increasing interest among the emergency medical services (EMS) community to break from traditional emergency response paradigms that bring all patients to the emergency department (ED), in favor of a patient-centered model featuring alternative destination options such as a primary care office, clinic, or urgent care center, as well as “treat-and-release” protocols. However, little data is currently available on the attitudes of patients toward assessment by EMS professionals in the field and the appropriateness of alternative transportation destinations. Successful redesign of the system requires the accurate assessment of patient perspectives. **Methods.** We conducted a cross-sectional survey among a convenience sample of patients or their family caregivers who presented to the ED. A survey was developed through an iterative process of writing, piloting, and evaluating questions for comprehension and content. In addition to basic demographic information and prior experience with EMS, the participants were asked for their level of agreement with 14 statements regarding current practice and proposed changes to traditional EMS systems using a Likert scale. Data analysis and descriptive statistics were performed using SPSS v. 18. **Results.** Among 54 subjects who completed the survey, 78% agreed or strongly agreed with the statement “I want EMS to do an evaluation and then advise me whether I need to go to the hospital.” Among the subjects, 67% indicated that they were comfortable being treated and released without seeing a physician and 70% felt comfortable being brought to an alternative destination. Also, 91% and 94% of the sampled patients agreed that EMS should have access to their medical records and be able to send care information electronically, respectively; and 85% indicated comfort with EMS’s coordinating treatment and transportation decisions with their doctor. **Conclusion.** Our results suggest that a significant proportion of patients expect EMS to provide an evaluation that informs the subsequent transportation decision and that patient-centered prehospital care systems would allow for a variety of treatment and transport options. Currently, financial and regulatory barriers exist that impede redesign of the system in accordance with the patient perspectives described in this study. Perhaps overcoming these barriers would allow EMS to better meet public expectations.

#### 86. DEMOGRAPHIC TRENDS IN AMBULANCE USE

Stephen Pitts, Graydon Lord, HHS Emergency Care Coordination Center

**Hypothesis.** We hypothesized that as the baby boom cohort ages, it will place an increasing burden on the providers of and payers for ambulance transport. **Methods.** We describe the characteristics of ambulance use by age and payer status in an annual sample of emergency department (ED) visits, the National Hospital Ambulatory Medical Care Survey (NHAMCS). Confounding and interaction were addressed with a regression model using complex survey methods. We defined an urgent visit as a visit classified by nurse triage as levels 1–3 of the five-level triage assessment used by NHAMCS. **Results.** Between 2003 and 2009, there were 18.3 million annual emergency medical services (EMS) transports, 16% of all ED visits to U.S.

EDs. Of all ambulance visits, 7.4 million (36%, 95% confidence interval [CI] 34 to 37) were aged 65 years or older. From 2003 to 2009, the average age of all patients visiting EDs increased significantly, by 0.18 years for each survey year. This trend disappeared when ambulance status was accounted for. Of Medicare visits, 35% (95% CI 34 to 37) were by ambulance, compared with 12% of other visits. Compared with Medicare-only patients, dual-eligible patients with both Medicare and Medicaid—a proxy for disability—were even more likely to arrive by ambulance ( $p = 0.02$  for the difference), despite being on average 7 years younger. The urgency of a visit was higher among ambulance arrivals, but Medicare patients arriving by ambulance had a lower-than-expected level of urgency. **Conclusions.** The cause of high and increasing ambulance use by the elderly and disabled deserves further study. It may be a consequence of either an unmet need or reimbursement policy, and poses challenges for the future of EMS.

#### 87. PNEUMOTHORAX VOLUME EXPANSION IN HELICOPTER EMS TRANSPORT

Derek Knotts, Annette Arthur, Matthew Thomas, Tim Herrington, Stephen Thomas, University of Oklahoma

**Background.** During air medical transport, the volume of a pneumothorax will increase as barometric pressure decreases in accordance with Boyle’s law. While not all medical literature agrees, preflight thoracostomy is often recommended even for patients with small pneumothoraces. We sought to characterize altitude-related volume changes in a pneumothorax model, aiming to improve clinical decisions for preflight thoracostomy in helicopter emergency medical services (HEMS) patients. **Methods.** This prospective study used three devices to measure air expansion at HEMS altitudes. The main device was an artificial pneumothorax model that mimicked a human pulmonary system with a 40-mL pneumothorax. Volume measurements were made by direct observation of the meniscus at the device syringe’s air–water interface. In addition, volume changes were calculated in two spherical balloons (6 L and 25 L) by measuring equatorial circumferences. All three models were flown in a Bell 206 aircraft, and measurements were recorded at 500-foot altitude increments from 1,000 to 5,000 feet above ground level. **Results.** The three models exhibited volume increases of 12.7%–16.2% at 5,000 feet compared with ground level. Univariate linear regression yielded similar increases, 1.27%–1.52%, in volume per 500-foot altitude increase for all three models. Bivariate-indexed linear regression identified no association between volume increase and assessment model ( $p$ -values 0.19 and 0.29). Locally weighted scatterplot smoothing (LOWESS) plots indicated linearity of the altitude–volume relationship. **Conclusion.** This study modeled predictable pneumothorax volume changes at typical HEMS altitudes. Increased understanding of altitude-related volume changes will aid in peritransport decision making.

#### 88. PARAMEDIC ATTITUDES REGARDING EXCEPTION FROM INFORMED CONSENT RESEARCH

Ralph Bledsoe, Glenn Bloom, York Hospital Emergency Medicine Residency

**Background.** Emergency medical services (EMS) research suffers from the paradox of informed consent and life-threatening situations. Research under exception from informed

consent (EFIC) was designed to foster research in situations where existing treatments were unproven or unsatisfactory and traditional informed consent was impractical given the patient's immediate need. The patient or his or her legally authorized representative is under duress in these situations. We investigated the understanding and comfort RAMPART-participating paramedics had with EFIC in a pilot survey. The authors know of no published research into paramedics' attitudes and beliefs about EFIC research. **Methods.** Following RAMPART's closure, EMS site coordinators were e-mailed a link to a SurveyMonkey.com survey of attitudes and feelings about EFIC research and asked to forward it to their enrolling paramedics. Wellspan Health's institutional review board exempted the study from review. The survey instrument was validated by cognitive testing of local RAMPART-trained paramedics. Paramedics in the authors' system did not participate. After completion, the participants could enter a drawing for \$50 gift cards. **Results.** Fifty-five paramedics averaging 17 years' experience completed the survey; 50 responded to all questions. Of the respondents, 49% felt research was more important than the right to consent, 16% felt the opposite, and 35% were neutral. Enrollers were significantly more likely to believe benefits outweighed autonomy; nonenrollers believed in equality between the two ( $p = 0.006$ ). Eighty-eight percent believed research on ambulances was important to improve future patient care, and three were negative; 64% believed a paramedic should "fully participate in any research their organization is participating in," while 34% felt objectors should be allowed not to enroll. In addition, 72% felt EFIC was ethical and 74% felt it to be legal. Further, 46% had enrolled patients, 48% had not but would enroll, and 6% would not have enrolled a patient. Analysis of variance was used to seek relationships between data points. **Conclusions.** Assuring future buy-in requires further research into paramedics' attitudes, and EMS workforce education is needed as prehospital EFIC research increases. The enrollers' greater belief in the weight of societal benefit merits further study. The respondents' experience demonstrates a need to train established providers in addition to newly certifying providers. Our small sample size and inability to track the response rate are limitations of this pilot.

#### 89. COMPARING WORK-RELATED STRESS AND STRESS REACTIONS IN AMERICAN AND CANADIAN EMS PERSONNEL

Elizabeth Donnelly, Paul Bradford, Severo Rodriguez, *University of Windsor*

**Background.** There are many similarities in how emergency medical services (EMS) are provided in the United States and Canada; however, significant structural and systemic differences in service provision exist. While extant literature has linked workplace stress to stress reactions in EMS personnel, virtually no attention has been given to exploring how those stresses and stress reactions may be influenced by the differences in the American and Canadian EMS systems. The goal of this study was to assess whether there are differences in work-related stresses and stress reactions in American and Canadian responders. **Methods.** Two online surveys were conducted utilizing the same instruments. In 2009, a probability sample of 12,000 nationally registered emergency medical technicians and paramedics were surveyed, with a 13.6% response rate ( $n = 1,633$ ). In 2011, paramedics in a municipality-based service in southwest Ontario were surveyed, with a 54% response rate ( $n = 145$ ). Respondents reported levels of oper-

ational and organizational chronic stress, critical incident stress, posttraumatic stress symptomatology (PTSS), alcohol use, and demographic characteristics. t-Tests and chi-square analyses were used to assess for significant differences. **Results.** American responders reported higher mean levels of operational stress (39.0 vs. 31.4; delta 7.6; 95% confidence interval [CI]: 5.5–9.7). Canadian responders reported higher levels of alcohol use (5.9 vs. 4.3; delta 1.6; 95% CI: 0.9–2.4). No significant differences were identified in organizational stress, critical incident stress, or PTSS. Significant demographic differences were also identified; American responders were significantly younger (35.1 vs. 38.3 years; delta 3.2; 95% CI: 1.3–5.1), had fewer years of experience in EMS (9.2 vs. 13.8; delta 4.6; 95% CI: 2.7–6.5), worked more hours weekly (4.1 vs. 3.9; delta 0.3; 95% CI 0.01–0.4), and reported lower income (3.6 vs. 6.7; delta 3.1; 95% CI 2.8–3.4). **Conclusion.** Significant variations were identified in self-reported operational stress, in alcohol use, and in demographic factors. The higher levels of operational stress in Americans may be the result of the increased number of hours at work, fewer years of experience, and lower wages. More investigation is needed to explicate how systemic differences in EMS systems may influence the health and well-being of EMS personnel.

#### 90. ALCOHOL USE AND MISUSE IN EMERGENCY MEDICAL SERVICES

Elizabeth Donnelly, *University of Windsor*

**Background.** Alcohol misuse has been identified as problematic for police officers and firefighters. Further, research has demonstrated that in police subculture, alcohol use is modeled as a way to deal with workplace-related stress. Despite the recognition that alcohol misuse occurs among other first responders, no systematic inquiry has been made into alcohol use among emergency medical services (EMS) personnel. The purpose of this study was to assess the prevalence of alcohol use among EMS personnel and ascertain what work-related factors were influential in predicting increased use of alcohol. **Methods.** A probabilistic sample ( $n = 12,000$ ) of nationally registered emergency medical services and paramedics were asked to respond to an online survey, reporting levels of operational stress, organizational stress, critical incident stress, posttraumatic stress, alcohol use (including whether they used alcohol to cope with a bad call or shift or they saw their colleagues using alcohol to cope), and demographic characteristics. Pearson correlation coefficients were used to estimate linear dependence between stress variables. Ordinary least-squares regression determined predictor variables independently associated with alcohol use. **Results.** A total of 1,633 responses were received (13.6% response rate). Among the respondents, 15.1% reported risky drinking; 1.3% reported possible alcohol dependence; 18.8% reported binge drinking at least monthly; 49.2% reported using alcohol to cope with a bad call or shift; and 83.7% reported seeing coworkers use alcohol to cope with a bad call or shift. Alcohol use was significantly correlated with critical incident stress ( $r = 0.08$ ,  $p < 0.01$ ) and with posttraumatic stress ( $r = 0.187$ ,  $p < 0.01$ ). Multivariate analysis revealed multiple significant predictors for alcohol use, including age ( $p < 0.01$ ), length of service ( $p < 0.05$ ), gender ( $p < 0.001$ ), marital status ( $p < 0.001$ ), operational stress ( $p < 0.001$ ), posttraumatic stress ( $p < 0.001$ ), using alcohol to cope ( $p < 0.001$ ), and seeing others use alcohol to cope ( $p < 0.001$ ). The final model had an adjusted  $R^2$  of 0.424. **Conclusion.** These findings indicate that alcohol use is prevalent among EMS personnel. To address potential

alcohol misuse, greater investment should be made to educate personnel about the risks associated with alcohol use and healthy coping techniques. Further, these findings reinforce the importance of making resources available to support personnel that may be misusing alcohol as a result of workplace stress.

#### 91. INCREASING PREHOSPITAL RECOGNITION OF SEPSIS: A FEASIBILITY STUDY TO EVALUATE THE USE OF LACTATE METERS AND TEMPORAL ARTERY THERMOMETERS BY PARAMEDICS

Lori Boland, Jonathan Hokanson, Tony Olson, Karl Fernstrom, Charles Lick, Allina Health

**Background.** To assess the feasibility of equipping prehospital providers with temporal artery thermometers (TATs) and handheld lactate meters to increase identification of patients at risk of sepsis. The correlation between prehospital and emergency department (ED) lactate values and the time interval that separates the availability of the two measures to clinicians were also evaluated. **Methods.** This pilot study used a convenience sample of prehospital patients meeting risk criteria for sepsis. Paramedics received education on systemic inflammatory response syndrome (SIRS) criteria and instruction on the use of TATs and handheld lactate meters. Patients were enrolled if they had a recent history of infection, met  $\geq 2$  SIRS criteria, and were being transported to a participating hospital. A lactate test was performed by paramedics in the prehospital setting and again upon arrival in the ED via usual care (i.e., venipuncture and laboratory processing). Paramedics entered study data using an online database accessible at the point of care. **Results.** Among 64 patients enrolled over 12 months, 32 had a prehospital body temperature of  $< 36^\circ\text{C}$  or  $> 38^\circ\text{C}$  by TAT. The range of prehospital lactate values was 0.8 to 9.8 mmol/L and the unadjusted Pearson correlation between prehospital and ED-measured lactate values was 0.70 ( $p < 0.001$ ). Among 10 patients whose prehospital lactate value was above the recommended threshold for early goal-directed therapy (EGDT; i.e., 4 mmol/L), eight had ED lactate values  $< 4$  mmol/L, although five had received fluids in the prehospital setting. The median time intervals between prehospital lactate measurement and 1) ED venipuncture and 2) ED lactate result available in the electronic hospital record were 76 minutes and 116 minutes, respectively. Of 56 study patients admitted to the hospital, 14 ultimately received a diagnosis of sepsis. **Conclusion.** Paramedics can identify patients meeting SIRS criteria and use TATs and handheld lactate devices to evaluate patients more comprehensively for sepsis risk. The clinical significance of prehospital lactate values  $> 4$  mmol/L requires further study, but if proven a reliable indicator, paramedics may be able to relay a key clinical alert value for EGDT approximately two hours earlier than is currently possible.

#### 92. A RELIABLE AND VALID TOOL FOR DETECTING ADVERSE EVENTS IN HELICOPTER EMS

P. Patterson, Judy Lave, Matthew Weaver, Chris Martin-Gill, Francis Guyette, Ronald Roth, Jon Rittenberger, Richard Wadas, Vincent Mosesso, Robert Arnold, Donald Yealy, *Department of Emergency Medicine, University of Pittsburgh*

**Background.** We sought to develop a reliable and valid tool to identify adverse events (AEs) in helicopter emergency medical services (HEMS). **Methods.** We adhered to a recommended multistep process for developing and

testing new measurements. First, we sought to develop a content-valid tool by convening an expert panel of three senior emergency medicine (EM)-trained physicians, three mid-career EM physicians, and four quality officers certified as flight paramedics and flight nurses. These experts met in eight face-to-face sessions to edit a draft list of 20 AE triggers and establish methods for rating proximal cause and severity of AEs. An example of a trigger is "cardiac arrest during transport." The experts rated the relevance of each AE trigger, each component of proximal cause, and each component of AE severity using an established four-point scale developed by Lynn et al., 1985. The scale included Not Relevant, Somewhat Relevant, Quite Relevant, and Highly Relevant. We then calculated the Item-level Content Validity Index (I-CVI) and removed items with less than 0.78 I-CVI in accordance with established benchmarks. Finally, we calculated the average Scale-level Content Validity Index (S-CVI) developed by Rubio et al. 2003 and Waltz, et al. 2005. **Results.** Experts reached consensus on 14 AE triggers, five categories for assigning proximal cause, and three categories for rating AE severity. We removed three of the 14 triggers with an I-CVI less than 0.78 (e.g., "time from dispatch to initial patient contact exceeds accepted standards"). The remaining triggers had a content validity mean I-CVI score of 0.94. The mean I-CVI for the five categories of proximal cause was 0.92. The mean I-CVI for the three levels of rating AE severity was 0.93. Overall, the content validity (S-CVI) for the three components of our method (triggers, proximal cause, and severity) was 0.93, with I-CVI ranging from 0.80 to 1.0. **Conclusions.** Initial tests confirm a content valid method for identifying AEs in HEMS.

**93. THE IMPACT OF HYPOTHERMIA TREATMENT ON SURVIVAL TO HOSPITAL DISCHARGE FOR OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS IN THE CIRCULATION IMPROVING RESUSCITATION CARE (CIRC) TRIAL**

Lars Wik, Jan Olsen, David Persse, Fritz Sterz, Michael Lozano, Marc Brouwer, Mark Westfall, Chris Souders, Reinhard Malzer, Pierre van Grunsven, David Travis, Ulrich Herken, Brooke Lerner, National Competence Center for Emergency Medicine

**Background.** Therapeutic hypothermia (TH) has been associated with increased survival after out-of-hospital cardiac arrest (OHCA). There is debate about when TH should be applied after OHCA. In the Circulation Improving Resuscitation Care (CIRC) trial, application of TH was captured for three distinct treatment periods: prehospital (PH), in the emergency department (ED), and in hospital (IH). A post hoc analysis of the CIRC database evaluated the effect of TH during these periods on survival to discharge. **Methods.** All study patients (both arms) admitted to hospital were included. Because patients could have TH initiated in the PH, ED, or IH phase of their care and not all patients had hypothermia maintained between one phase of care and the next, a TH score was created. The score awarded points for each location where TH was provided: 3 for PH, 2 for ED, and 1 for IH. A maximum score of 6 was received if they had TH in all three settings; the minimum score was 0 if no TH was provided. Logistic regression was used to determine the interaction between the TH score and survival to hospital discharge, adjusting for the same covariates used in the CIRC study's survival analysis: shockable initial rhythm, witnessed arrest, age group, and study site. **Results.** Of the 4,231 subjects enrolled, 1,068 were admitted to hospital.

Survival information unknown for two subjects. Of the remaining 1,066, 36% had a score of 0 (no TH), 8% score of 1 (IH-TH only), 3% score of 2 (ED-TH only), 26% score of 3, 6% score of 4, 3% score of 5, and 17% score of 6 (PH-, ED-, and IH-TH). The adjusted odds ratio (OR) for survival to discharge was 1.105 (95% confidence interval 1.030–1.186,  $p < 0.01$ ) for each one-point increase in the TH score. For example, a subject who received PH-, ED-, and IH-TH (score of 6) had an OR of 1.8 for survival to hospital discharge. **Conclusion.** Our analysis indicates that TH treatment in OHCA patients shows the most benefit when started in the field and continued into the hospital without interruptions in the ED.

**94. EFFECTS OF COMPRESSION RATE ON CORONARY PERFUSION PRESSURE AND CAROTID BLOOD FLOW IN A PORCINE MODEL OF SHOCK-INDUCED PULSELESS ELECTRICAL ACTIVITY**

Xiaobo Wu, Weilin Quan, Yinlun Weng, Wei Chen, Shijie Sun, Wanchun Tang, Weil Institute of Critical Care Medicine

**Background.** The 2010 American Heart Association guidelines recommend a chest compression (CC) depth of at least 2 inches. However, most clinical studies found an inverse association between CC depth and rate. The effect of CC rate on coronary perfusion pressure (CPP) and carotid blood flow (CBF) has not been determined. This study was conducted to investigate hemodynamic responses to CC at different compression rates in a porcine model of postshock pulseless electrical activity (PEA). **Methods.** Ventricular fibrillation was electrically induced and untreated for 2–7 minutes in 12 domestic pigs weighing 22–24 kg. Postshock PEA was induced with electric shock. Peak aortic pressure below 40 mmHg was used to identify a qualified PEA. Once PEA was induced, the animals received 30 seconds of PEA-triggered synchronized sternal CCs using a modified Thumper device. The CC depth was maintained at 2 inches. If the animals were resuscitated after the study sequence, PEA induction and the study sequence were repeated after 30 minutes of recovery. **Results.** A total of 1,102 compression cycles from 29 qualified PEA events were included in the analyses. The rate of induced PEA varied from 30 to 125 bpm. When the CC rate increased from 80 to 120 bpm with fixed CC depth, CPP increased by 5.6 mmHg (32.9%) and CBF increased by 46.4 mL/min (50.2%). Both CPP and CBF were positively correlated to CC rate, with correlation coefficients of 0.32 and 0.49, respectively. Linear regression found a positive trend for both CPP and CBF, with slopes over the CC rate of 0.14 and 1.16, respectively. **Conclusions.** In this shock-induced PEA porcine model, both CPP and CBF increased with CC rate. These results indicate that faster sternal CC would generate better coronary and cerebral perfusion in the range from 80 to 120 bpm.

**95. REEVALUATING EPINEPHRINE IN OUT-OF-HOSPITAL CARDIAC ARREST: A SYSTEMATIC REVIEW AND META-ANALYSIS**

Steve Lin, Clifton Callaway, Prakeshkumar Shah, Justin Wagner, Joseph Beyene, Laurie Morrison, Rescu, Li Ka Shing Knowledge Institute, St. Michael's Hospital

**Background.** International resuscitation guidelines support the routine administration of epinephrine during out-of-hospital cardiac arrest (OHCA). However, the evidence is not clear for the efficacy of epinephrine in long- and short-term survival. **Objective.** To evalu-

ate the efficacy of epinephrine (all doses and combinations) in adult OHCA patients on long-term outcomes (survival to discharge) and short-term outcomes (survival to admission or return of spontaneous circulation [ROSC]). **Methods.** The search included Medline, EMBASE, and the Cochrane Library up to March 1, 2012, and hand-searches of bibliographies and electronic resources to identify eligible published and unpublished randomized controlled trials (RCTs). Eligible trials compared epinephrine with vasopressin or placebo in adult OHCA patients. Two independent reviewers conducted the hierarchical selection, abstracted data, and assessed quality. Disagreement was resolved by consensus. The Mantel-Haenszel random-effects method was used to test for differences. A subgroup analysis was performed using stratification by location (prehospital or emergency department). **Results.** Fourteen RCTs ( $N = 12,246$ ) met the inclusion criteria: six compared standard-dose epinephrine (SDE) with  $\geq 5$ -times higher-dose epinephrine (HDE) ( $n = 6,174$ ), six compared SDE with epinephrine-vasopressin combination ( $n = 5,202$ ), one compared SDE with vasopressin alone ( $n = 336$ ), and one compared SDE with placebo ( $n = 534$ ). There was no survival-to-discharge advantage. HDE showed improved survival to admission (relative risk [RR] 1.15 [95% confidence interval (CI): 1.00–1.32],  $p = 0.05$ ) and ROSC (RR 1.17 [95% CI: 1.03–1.34],  $p = 0.02$ ) over SDE. SDE showed improved survival to admission (RR 1.95 [95% CI: 1.34–2.84],  $p < 0.001$ ) and ROSC (RR 2.80 [95% CI: 1.78–4.41],  $p < 0.001$ ) over placebo in the single RCT. HDE and the epinephrine-vasopressin combination improved survival to admission when stratified by prehospital setting (RR 1.15 [95% CI: 1.00–1.32],  $p = 0.05$ ) and emergency department (RR 1.20 [95% CI: 1.04–1.38],  $p = 0.01$ ), respectively. **Conclusions.** There was no clear advantage of any vasopressor in long-term survival. Similar short-term benefit was seen with HDE over SDE and SDE over placebo, suggesting that HDE should be a treatment option in current resuscitation guidelines.

**96. TEAM CPR: EVALUATION OF A METHOD TO ENABLE YOUNGER CHILDREN TO PERFORM MORE EFFECTIVE CHEST COMPRESSIONS**

Chad Panke, Angelo Salvucci, Lynn White, David Chase, Barbara Sprackles-Wilkins, American Medical Response

**Background.** Prompt continuous high-quality cardiopulmonary resuscitation (CPR) increases survival in cardiac arrest. Although children aged 8 years can learn the theory and mechanics of CPR, they typically do not have sufficient size or strength to perform effective chest compressions. The purpose of this study was to examine the effectiveness of a simultaneous two-rescuer chest compression method performed by young children. **Methods.** This was a pilot study to describe the quality of chest compressions done by children as individuals and as a two-person team. Volunteer children, without previous CPR training, were trained and asked to perform 150 chest compressions at a 30:2 compression-to-ventilation ratio on the SmartMan manikin system (Ambu, Inc.). A metronome was used to prompt the rate. Within two-person teams, subjects first performed alone. They were then taught how to position themselves on opposite sides of the manikin chest and place their hands next to each other on the lower sternum to perform simultaneous chest compressions, and then performed 150 compressions at 30:2 as a team. The examiner and subjects were blinded to the results. Two-tailed t-tests were used to

compare chest compression quality parameters in individual and team tests. **Results.** Sixteen subjects completed both tests. Eight were male; their ages were 6–9 years, heights were 44–53 inches, and weights were 43–80 lb. Of the 2,268 compressions performed by individual subjects, the median depth was 0.89 inches. Of the 1,245 compressions performed by two-person teams, the median depth was 1.17 in. The median increase in depth by team over individual chest compressions was 0.29 in ( $p = 0.015$ ). No individual or team median achieved the recommended minimum depth of 2 in. The metronome-guided rate was equivalent among all groups. **Conclusions.** In this study the quality of chest compressions performed by young children was significantly better when done using the team method. Although teams did not reach the American Heart Association Guidelines 2010–recommended depth, team CPR was superior to individual efforts. The team CPR method may allow younger children, or any group of rescuers unable to reach adequate chest compression depth as individuals, to improve the effectiveness of CPR.

#### 97. A BLINDED EVALUATION OF COMBINATION DRUG THERAPY FOR PROLONGED VENTRICULAR FIBRILLATION CARDIAC ARREST

Timothy Mader, Ryan Coute, Scot Millay, Adam Kellogg,  
Baystate Medical Center/Tufts University School of Medicine

**Background.** There are many examples in which medical disease treatments have been innovated from single-agent, failure-based, serial medication delivery to first-line combination drug therapy. Could the same approach improve outcomes in the metabolic phase of ventricular fibrillation (VF)? **Objective.** Using a swine model of prolonged VF, we compared return of spontaneous circulation (ROSC) and 20-minute survival in animals treated with single agents given in series to animals provided first-line combination drug therapy. **Methods.** The study was approved by the Institutional Animal Care and Use Committee. Eighty swine (25–30 kg) were surgically instrumented under anesthesia, and VF was electrically induced. After 12 minutes of untreated VF, the animals were 2:1 block-randomized to one of two resuscitation schemes. The SERIES group ( $n = 53$ ) received the following series: standard-dose epinephrine (0.01 mg/kg [SDE]); vasopressin (0.57 mg/kg); amiodarone (4.3 mg/kg) and SDE; sodium bicarbonate (1 mEq/kg) and SDE—each delivery punctuated by a rescue shock (RS) after 3 minutes of cardiopulmonary resuscitation (CPR). If ROSC occurred after any RS, supportive care was provided and subsequent medications were not given. The COCKTAIL group ( $n = 27$ ) received all drugs together (with metoprolol [0.2 mg/kg]), followed by CPR and the first RS. An SDE followed each failed RS. All drugs were given intravenously with a flush. CPR and RS attempts were standardized. Resuscitation continued until ROSC was achieved or 20 minutes elapsed without ROSC. Group comparisons were assessed using descriptive statistics. Proportions with 95% confidence interval (CI) were calculated for VF termination, ROSC, and survival. **Results.** At baseline, the two groups were similar. Of the 27 animals in the COCKTAIL group, VF was terminated in 24 (proportion: 0.89 [95% CI 0.72–0.96]), six animals experienced ROSC (proportion: 0.22 [95% CI 0.11–0.41]), and five achieved 20-minute survival (proportion: 0.19 [95% CI 0.08–0.37]). Of the 53 animals in the SERIES group, VF was terminated in 47 (proportion: 0.89 [95% CI 0.77–0.95]), 30 animals experienced ROSC (proportion: 0.57 [95% CI 0.43–0.69]), and 28 animals achieved 20-minute

survival (proportion: 0.53 [95% CI 0.40–0.66]). The SERIES outcomes mirrored those of historical controls (VF termination proportion: 0.82, ROSC proportion: 0.59, and 20-minute survival proportion: 0.40). **Conclusion.** In this swine model of prolonged out-of-hospital cardiac arrest, short-term outcomes were adversely affected by this drug-dosage combination.

#### 98. VIDEO-ASSISTED FEEDBACK DURING CPR: ANALYSIS OF SMARTPHONE VIDEO FOOTAGE ACCURATELY CLASSIFIES CHEST COMPRESSION RATE

Adam Frisch, Samarjit Das, Joshua Reynolds, Jestin Carlson, Fernando De la Torre, Jessica Hodgins, UPMC

**Background.** Real-time cardiopulmonary resuscitation (CPR) feedback improves chest compression (CC) rate in the prehospital setting; however, few such tools exist for lay rescuers. Smartphone applications utilizing an embedded gyroscope can provide CPR feedback, but this requires purchase of additional accessories that may not be readily available when needed. We evaluated whether video footage from a smartphone camera could be used to determine CC rate during simulated bystander CPR. **Hypothesis.** Analysis of smartphone video footage can discriminate between CCs performed too slowly (<100 compressions/min), too quickly (>120 compressions/min), or within recommended ranges (100–120 compressions/min). **Methods.** Six subjects previously trained in CPR performed CCs on a CPR manikin. Each subject performed five 30-second bouts at specified parameters: normal rate/normal depth, normal rate/too deep, normal rate/too shallow, too fast/normal depth, and too slow/normal depth. Participants were recorded using a smartphone camera placed flat on the floor between them and the manikin. Inertial measurement devices attached to the participants' hands determined actual compression rate. We divided each video recording into 2-second epochs, calculating the overall classification accuracy of video segments via two different methods using a computer vision algorithm for determining repetitive movement patterns from video. **Analysis I:** Half the video segments from each subject were used as a training set, and the other half was a test set. **Analysis II:** All the video segments from half of the subjects were used as a training set, and the other subjects were a test set. We determined overall classification accuracy by k-nearest neighbors. **Results.** Smartphone video recording yielded high-quality video for analysis, generating a total of 153 video segments. Recorded CC rates ranged from 60 to 144 per minute. **Analysis I** yielded an overall classification accuracy of 88% (95% confidence interval 82.2–92.4); **analysis II** yielded an overall classification accuracy of 80% (72.6–85.3). **Conclusion.** Analysis of video obtained from a smartphone accurately classifies CC rate into three categories: too fast, too slow, or within a desired range. Smartphone applications integrating this technology could provide real-time CPR feedback regarding CC rate to lay rescuers without the need for additional accessories.

#### 99. ASSESSING THE ACCURACY OF ED VS EMS COMPUTER ECG INTERPRETATION FOR IDENTIFYING ACUTE MYOCARDIAL INFARCTION

Kelly Sawyer, Stephanie Hang, Amy Kule, Alfred Burris, Justin Trivax, Robert Swor, William Beaumont Hospital

**Background.** Emergency medical services (EMS) systems and emergency departments (EDs) have used computer interpretation of electrocardiograms (CI-ECG) to shorten

triage time and decrease door-to-balloon time for patients with acute myocardial infarction (AMI). However, device-specific algorithms may potentiate inconsistencies in interpretation. Our objectives were to evaluate the performance characteristics of EMS and ED CI-ECG and to assess their agreement for the diagnosis of coronary artery occlusion using angiography as the “gold standard.” **Methods.** We examined a retrospective cohort of adult, EMS-transported patients whose ECGs were obtained both by EMS (EMS-ECG) and ED (ED-ECG) ECG devices and were taken emergently to the cardiac catheterization laboratory for suspicion of AMI. This study was conducted at a single academic community ED from January 2006 to February 2011. Cases were dichotomized as either “CI-ECG+,” defined as “AMI suspected” by computer printout, or as “CI-ECG-.” The primary outcome (“definite AMI”) was determined by evidence for acute coronary vessel occlusion or presence of thrombus in a culprit vessel on angiography. To assess the relative accuracy of EMS-ECG and ED-ECG, we calculated the sensitivity, specificity, and likelihood ratios (LRs) of each device type to predict coronary artery occlusion; the kappa value assessed device agreement for AMI diagnosis. **Results.** A total of 173 patients were identified. The mean time from EMS-ECG to reperfusion was 81.9 (standard deviation [SD]  $\pm 25.6$ ) minutes and that from ED-ECG to reperfusion was 56.0 (SD  $\pm 20.4$ ) minutes. Overall, 116 (67.0%) cases had coronary occlusion on angiography. Performance characteristics for EMS-ECG and ED-ECG for definite AMI revealed sensitivity of 62.9% (53.4, 71.6) and 50.0% (40.5, 59.4); specificity of 36.8% (24.8, 50.7) and 64.9% (51.0, 76.8); LR+ of 0.99 (0.78, 1.27) and 1.42 (0.96, 2.12); and LR- of 1.01 (0.75, 1.35) and 0.77 (0.62, 0.94), respectively. There was poor agreement on AMI diagnosis between devices ( $\kappa$  0.23 [95% confidence interval 0.09, 0.37]). **Conclusion.** Using coronary angiography as a gold standard, neither device's CI-ECG was accurate for identifying coronary artery occlusion, nor was there significant agreement between EMS and ED CI-ECG diagnoses. Further work is needed to understand the relative value of CI-ECG in the diagnosis of coronary artery occlusion in the ED.

#### 100. ASSESSMENT OF ADVERSE EVENTS IN A PRIMARY CARE PARAMEDIC ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION BYPASS PROGRAM IN A LARGE RURAL AREA

Mark Froats, Andrew Reed, Richard Dionne, Justin Maloney, Rob Burns, Queen's University

**Background.** This study was conducted to determine the frequency and nature of adverse events in a basic life support (BLS) ST-segment elevation myocardial infarction (STEMI) bypass program in a large rural area. In our region, BLS providers bypass closer emergency departments (EDs) to deliver patients to percutaneous coronary intervention (PCI) centers up to 60 minutes away, exceeding the 30-minute limit recommended by the American Heart Association. The safety of this transport time and non-advanced life support (non-ALS) providers attending STEMI patients during bypass has been questioned. **Methods.** We conducted a health records review for patients transported by a rural BLS emergency medical services (EMS) agency under bypass to our regional PCI center. Patients were eligible if they had less than 12 hours of chest pain, a STEMI-positive electrocardiogram, and a drive time to the PCI center within 60 minutes. We determined transport times and adverse events during transport, which were

bradycardia (<50 bpm), tachycardia (>140 bpm), hypotension (systolic blood pressure <90 mmHg), cardiac arrest, and death. We conducted descriptive data analyses with 95% confidence intervals (CIs). **Results.** Forty-five consecutive cases were identified between February 2005 and February 2012. The mean age was 61.2 years, with 32 (71.1%) male patients. The mean transport time was 30.0 minutes, and 13 cases (28.9%) exceeded this (range 31–62 minutes). Twenty cases (44.4%) had an adverse event. The event rate for cases with drive time under 30 minutes was 40.0% (95% CI 22.5–57.5%), compared with 46.2% (95% CI 19.1–73.3%) for cases with longer drive times. Of three events occurring after 30 minutes of transport, there was one ventricular fibrillation arrest that responded to one shock, and two transient episodes of hypotension. Fifteen (75.0%) of the adverse events were transiently abnormal vital signs requiring no intervention. Four adverse events (20.0%) would have benefited from an ALS intervention. None of these would have been transported if the vital sign adverse event parameters and abnormal Glasgow Coma Scale score were contraindications to bypass. There were no deaths. **Conclusion.** BLS EMS providers in a rural county may be able to safely bypass the closest ED and transport STEMI patients to a PCI facility provided there are no vital sign contraindications at initial presentation. There was no difference in adverse event rate with extended drive times.

**101. EFFECT OF CONTINUOUS POSITIVE AIRWAY PRESSURE (CPAP) ON MORTALITY IN THE TREATMENT OF ACUTE CARDIOGENIC PULMONARY EDEMA IN THE PREHOSPITAL SETTING: RANDOMIZED CONTROLLED TRIAL**

**Michael Austin, Karen Wills, David Kilpatrick, Ottawa Hospital**

**Background.** The prehospital use of continuous positive airway pressure (CPAP) ventilation is a relatively new management for acute cardiogenic pulmonary edema (ACPE), and there is little high-quality evidence of the benefits or potential dangers in this setting. The aim of this study was to determine whether patients in severe respiratory distress treated with CPAP in the prehospital setting have a lower mortality than those treated with usual care. **Methods.** Randomized controlled trial comparing usual care versus CPAP (WhisperFlow®) in a prehospital setting, for adults experiencing severe respiratory distress, with falling respiratory efforts, due to a presumed ACPE. Patients were randomized to receive either usual care, including conventional medications (nitrates, furosemide, and oxygen) plus bag-valve-mask ventilation, versus conventional medications plus CPAP. The primary outcome was prehospital or in-hospital mortality. Secondary outcomes were the need for tracheal intubation, length of hospital stay, change in vital signs, and arterial blood gas results. We calculated relative risk (RR) with 95% confidence intervals (CIs). **Results.** Fifty patients were enrolled, with a mean age of 79.8 years ( $\pm$  standard deviation [SD] 11.9), male 56.0%, and mortality 20.0%. The risk of death was significantly reduced in the CPAP arm, with mortality 34.6% (9 deaths) in the usual-care arm compared with 4.2% (1 death) in the CPAP arm (RR, 0.12; 95% CI 0.02 to 0.88;  $p = 0.04$ ). Patients who received CPAP were significantly less likely to have respiratory acidosis (mean difference in pH 0.09; 95% CI 0.01 to 0.16;  $p = 0.02$ ;  $n = 24$ ) than patients receiving usual care. The length of hospital stay was significantly shorter for the patients who received CPAP (mean difference 2.3 days;

95% CI -0.01 to 4.6,  $p = 0.05$ ). **Conclusion.** We found that CPAP significantly reduced mortality, respiratory acidosis, and length of hospital stay for patients in severe respiratory distress caused by ACPE. This study shows that the use of CPAP in the prehospital setting for ACPE improves patient outcomes. Trial reg.: ANZCTR ACTRN12609000410257. Funding: Fisher and Paykal, suppliers of the WhisperFlow CPAP device.

**102. INITIAL IMPACT OF PREHOSPITAL ELECTROCARDIOGRAMS ACQUIRED BY BASIC LIFE SUPPORT PARAMEDICS ON PROCESSES OF CARE IN PATIENTS WITH ST-SEGMENT ELEVATION MYOCARDIAL INFARCTION: A PROVINCEWIDE EVALUATION**

**Lucy Boothroyd, Yongling Xiao, Laurie Lambert, Eli Segal, Dave Ross, Sébastien Maire, Peter Bogaty, Institut National d'Excellence en Santé et en Services Sociaux**

**Background.** In a systematic, Canadian provincewide evaluation of ST-segment elevation myocardial infarction (STEMI), we examined the association of processes of care and mortality with prehospital electrocardiograms (phECGs), early in their implementation by basic life support (BLS) paramedics. **Methods.** All 82 acute care Quebec hospitals that treated at least 30 patients with acute myocardial infarction (AMI) participated in a six-month evaluation in 2008–2009. At that time, seven of 16 provincial regions had implemented phECG acquisition by BLS paramedics. Hospital charts, phECGs, and first emergency room (ER) ECGs of AMI patients presenting to an ER with acute symptoms were systematically reviewed by medical record librarians and two cardiologists to identify STEMI and ambulance use. Survival data and diagnoses in the previous five years were identified from linkage to vital statistics and hospital discharge databases. Times are expressed as medians with interquartile range (IQR). **Results.** Of 1,222 STEMI patients transported by ambulance, 139 (11%) had a phECG. For 79% of these, paramedics alerted the receiving ER or transmitted the phECG. Two-thirds of phECG patients were transported directly to a percutaneous coronary intervention (PCI) center (vs. 33% without phECG), and 18% were transferred to a second hospital for PCI (vs. 50% without phECG; both  $p < 0.001$ ). Presenting patient characteristics (including anterior AMI and Thrombolysis In Myocardial Infarction [TIMI] risk index), cardiac and noncardiac comorbidities, and symptoms-to-ER delay did not differ for patients with and without phECGs. In-hospital delays were shorter for phECG patients, with minimal increase (3 min) in prehospital times: door-to-ECG time was 5 minutes (IQR = 2–10) vs. 8 minutes (2–15) without phECG ( $p < 0.001$ ); door-to-needle time was 19 minutes (17–29) vs. 26 minutes (20–45) ( $p = 0.09$ ); door-to-balloon time was 50 minutes (37–76) vs. 95 minutes (71–123) ( $p < 0.001$ ). There was a trend for lower risk-adjusted one-year mortality for phECG patients. Despite similarity in patient factors, phECG transmission versus nontransmission was associated with more timely PCI ( $p = 0.001$ ). **Conclusions.** In this initial implementation of phECG capability in the BLS setting, critical treatment delays have been markedly reduced. Given the well-established relation between faster treatment and mortality reduction, widespread introduction of phECGs can be expected to improve survival of STEMI patients.

**103. DOES PREHOSPITAL ADMINISTRATION OF NITROGLYCERIN FOR CHEST PAIN CAUSE HYPOTENSION IN ACUTE INFERIOR WALL STEMI? A RETROSPECTIVE COHORT STUDY**

**Dave Ross, Laurie Robichaud, Marie-Hélène Proulx, Sébastien Légaré, Charlene Vacon, Xiaoqing Xue, Eli Segal, Urgences-santé; Hôpital du Sacré-Coeur de Montréal**

**Background.** Patients with inferior ST-segment elevation myocardial infarction (STEMI), associated with right ventricular infarction, are potentially at higher risk of developing hypotension when administered nitroglycerin (NTG). However, current basic life support primary care paramedic (PCP) protocols do not differentiate location of STEMI prior to NTG administration. **Objective.** We sought to determine whether NTG administration is more likely to cause hypotension (systolic blood pressure <90 mmHg) in inferior STEMI compared with noninferior STEMI. **Methods.** We conducted a retrospective chart review of prehospital patients with chest pain of suspected cardiac origin and computer-interpreted prehospital electrocardiograms (ECGs) indicating “acute MI.” Computerized interpretation was performed by the GE Marquette 12SL®-Zoll E Series. Patients were treated by PCPs. We included all local STEMI cases identified as part of a provincial STEMI registry project. Charts were reviewed by trained data extractors using a predefined instruction list. Univariate analysis was used to compare differences in proportions of hypotension after NTG administration, drop in systolic blood pressure greater than or equal to 30 mmHg, and hypotension on initial prehospital blood pressure between patients with inferior wall STEMI and those with STEMI in another region (noninferior). **Results.** Over a 29-month period, we identified 1,466 STEMI patients. Of those, 798 (54.4%) had complete data and received NTG. Hypotension occurred after NTG in 36 of 461 inferior STEMI and 29 of 337 noninferior STEMI, 7.8% vs. 8.6%,  $p = 0.69$ . A drop in systolic blood pressure greater than or equal to 30 mmHg occurred in 23.5% of inferior STEMI and 23.8% of noninferior STEMI,  $p = 0.91$ . Initial hypotension was noted in significantly more inferior STEMI compared with noninferior STEMI, 9.9% vs. 4.9%,  $p = 0.005$ . Interrater agreement for chart review of the primary outcome was excellent ( $\kappa = 0.94$ ). **Conclusion.** Patients with chest pain and inferior wall STEMI on their computer-interpreted prehospital ECG who receive nitroglycerin do not seem to develop hypotension more frequently than patients with STEMI in other territories, although they are more commonly hypotensive on presentation. Current PCP protocols for NTG administration in computer-interpreted prehospital ECG STEMI appear to be safe.

**104. COMPUTER 12-LEAD INTERPRETATION INFLUENCES PARAMEDICS TO OVERTRIAGE ACUTE MYOCARDIAL INFARCTION**

**Todd Burgbacher, Spencer Brady, Craig Manifold, Christopher Velasquez, David Wampler, University of Texas Health Science Center at San Antonio**

**Background.** Emergency medical services (EMS) personnel are often tasked with making the decision to call “heart alert,” which prepares hospitals to receive the most time-sensitive form of heart attacks. There is significant hospital cost associated with heart alert activation. Historically, the computer’s interpretation of the 12-lead electrocardiogram

(ECG) is hypersensitive, and overcalls acute myocardial infarction (AMI). It is imperative that paramedics be able to accurately interpret the 12-lead ECG in order to reduce delay in definitive care, thereby reducing morbidity and mortality. The objective of this study was to determine the impact of the computer-generated diagnostic interpretation on the correct paramedic activation of heart alert based on difficult ECG. **Methods.** Twenty-five ECGs were selected from an in-house library to include a mix of false AMI determinations, appropriate AMI determinations, and missed AMI interpretations. Each ECG was duplicated with the computer interpretation deleted from the duplicate. All ECGs were formally randomized and formatted as a test. All 50 questions contained identical patient information (i.e., patient was diaphoretic and complaining of chest pain) and administered to a random selection of on-duty paramedics. Responses were dichotomous for patient eligibility for heart alert. **Results.** The test was given to 42 paramedics resulting in 1,050 ECG pairs assessed. Each ECG pair had at least 1 inconsistency with a total of 183 inconsistencies. Of the inconsistencies, 94 (51%) followed the pattern of calling heart alert with the computer interpretation of AMI and not calling the heart alert on the same ECG if the computer interpretation was blinded. Twenty-five true AMIs were not identified without the computer-generated interpretation. Two ECGs revealed AMI where the computer algorithm failed to recognize it; the paramedics were twice as likely to appropriately identify those ST-segment elevation myocardial infarctions (STEMIs) when the computer interpretation was blinded. **Conclusion.** Paramedics were more likely to trigger heart alert on difficult ECGs if the computer interpretation displayed AMI, rather than if the computer interpretation was blinded. False activations of heart alert may be reduced if computer interpretation is disabled, at the risk of missing more AMIs.

#### 105. TIME INTERVALS AND REARREST AFTER OUT-OF-HOSPITAL CARDIAC ARREST

Allison Koller, David Salcido, Clifton Callaway, James Menegazzi, University of Pittsburgh

**Background.** Rearrest (RA) occurs when a patient loses pulses following return of spontaneous circulation (ROSC) after out-of-hospital cardiac arrest (OHCA), but the exact causes of RA are not fully understood. Time-to-treatment intervals may affect patient outcome and could be a plausible contributor to RA. **Objectives.** To compare emergency medical services (EMS) time intervals between cases with and without RA. We hypothesized that RA cases will have significantly longer time intervals than non-RA cases. **Methods.** The Institutional Review Board of the University of Pittsburgh approved this study. Cases of EMS-treated, nontraumatic OHCA from 2006 to 2011 with at least one instance of prehospital ROSC were retrospectively gathered from the Pittsburgh site of the Resuscitation Outcomes Consortium. Prehospital event times were derived from computer-assisted dispatch records. We calculated time intervals to the nearest minute, including 9-1-1 call to EMS arrival, arrival to first EMS cardiopulmonary resuscitation (CPR), EMS CPR to ROSC, and 9-1-1 call to arrival at the emergency department (ED). RA status was determined from electronic defibrillator downloads and patient care reports. We used logistic regression to examine the association between RA and each time interval while controlling for patient

demographic and clinical variables with  $\alpha = 0.05$ . **Results.** Two-hundred thirty-five cases were analyzed, and 79 (34%) cases had an instance of RA. The RA group had a significantly higher proportion of males and shocked cases than the non-RA group. Additionally, the RA group had a significantly higher amount of shocks delivered than the non-RA group. Odds ratios for the outcome of RA by time interval were as follows: 9-1-1 to arrival: 1.09 (confidence interval [CI]: 0.98–1.21,  $p = 0.10$ ); arrival to CPR: 1.02 (CI: 0.89–1.19,  $p = 0.74$ ); CPR to ROSC: 0.99 (CI: 0.96–1.02,  $p = 0.86$ ); and 9-1-1 to ED: 0.99 (CI: 0.96–1.01,  $p = 0.35$ ). All other variables were not significant. **Conclusion.** EMS time intervals for OHCA were not predictive of RA.

#### 106. TREATMENT AT A STEMI CENTER IS ASSOCIATED WITH FAVORABLE OUTCOMES FOLLOWING OUT-OF-HOSPITAL CARDIAC ARREST

Bryn Mumma, Deborah Diercks, Beate Danielsen, James Holmes, UC Davis

**Background.** The American Heart Association recommends regionalized post-out-of-hospital cardiac arrest (OOHCA) care at cardiac resuscitation centers that are closely aligned with ST-segment elevation myocardial infarction (STEMI) centers. However, the effect of STEMI centers on outcomes following OHCA remains unknown. We hypothesize that treatment at a STEMI center is associated with increased survival and neurologic recovery among OOHCA patients. **Methods.** We included patients aged 18 years or older with OOHCA in the 2010 California Emergency Medical Services Information Systems (CEMSIS) database whose CEMIS record was linked to an inpatient record from the California Office of Statewide Health Planning and Development (OSHPD) database. The CEMIS database is a unified emergency medical services (EMS) data-collection system, and the OSHPD database contains patient-level data for all inpatient and emergency department encounters. We linked CEMIS and OSHPD records using probabilistic linkage. Multiple logistic regression models including age, gender, race, ethnicity, EMS response time, cardiac arrest rhythm, payer category, hospital size, teaching status, and trauma center status were used to evaluate the association between STEMI center treatment and outcomes. A STEMI center was defined as one with 24-hours-a-day/seven-days-a-week percutaneous coronary intervention capability. Good neurologic recovery was defined as discharge to home, a residential care facility, a psychiatric facility, or prison/jail, or leaving against medical advice. **Results.** We identified 8,481 patients with OOHCA in the CEMIS database; 3,620 were linked to OSHPD inpatient records. The majority (74.0%) were treated at STEMI centers. The median age was 71 years (interquartile range 60–83). Survival to hospital discharge was similar between the two groups (26.3% vs. 25.8%;  $p = 0.76$ ), but good neurologic recovery was higher among those treated at STEMI centers (18.2% vs. 10.4%;  $p < 0.0001$ ). In the adjusted analysis, treatment at a STEMI center was associated with good neurologic recovery (odds ratio [OR] 2.3, 95% confidence interval [CI] 1.6–3.4;  $p < 0.0001$ ) but not survival to discharge (OR 1.3, 95% CI 0.98–1.7;  $p = 0.07$ ). **Conclusions.** Treatment at a STEMI center following OOHCA was associated with favorable recovery outcomes. Our data suggest that regionalized post-OOHCA care in accordance with American Heart Association guidelines may improve neurologic recovery following OOHCA.

#### 107. CPR QUALITY AND OUTCOMES IN RESUSCITATION OF SUSPECTED DRUG-RELATED CARDIAC ARRESTS

Allison Koller, David Salcido, Clifton Callaway, James Menegazzi, University of Pittsburgh

**Background.** Cardiac arrest resulting from drug overdose (OD) is a significant public health issue and is the cause of many preventable deaths each year. Little is known about actual resuscitation process parameters of ODs, and such arrests are often excluded from out-of-hospital cardiac arrest (OHCA) studies. We sought to investigate the characteristics of emergency medical services (EMS)-treated OHCA cases resulting from suspected OD. **Methods.** The University of Pittsburgh Institutional Review Board approved this study. Data from EMS-treated nontraumatic OHCA cases were obtained from the Pittsburgh site of the Resuscitation Outcomes Consortium, a multi-center clinical research consortium with 10 sites across North America. Cases from 2006–2011 were analyzed. Case definition for OD was naloxone administration or drug overdose indicated on the patient care report. Resuscitation parameters including chest compression fraction, compression rate, and compression depth, shock delivery, and the administration of resuscitation drugs were collected and compared between OD and non-OD groups. Demographic and outcome variables including age, gender, EMS- or bystander-witnessed status, return of spontaneous circulation, and survival to hospital discharge were also compared by OD status. Resuscitation parameters were compared between groups using logistic regression or t-tests with  $\alpha = 0.05$ . **Results.** We identified 180 OD cases and compared them with 2,162 non-OD OHCA cases. Both groups were predominantly male (OD: 66%, non-OD: 59%;  $p = 0.0498$ ). OD OHCA cases were on average 20 years younger than non-OD OHCA cases (45 vs. 65 years,  $p < 0.001$ ). OD cases were associated with higher overall cardiopulmonary resuscitation (CPR) fraction than non-OD (66% vs. 63%,  $p = 0.0158$ ) and survival (OD: 19%, non-OD: 11%; odds ratio [OR]: 1.82, CI: 1.12–2.94,  $p = 0.015$ ). OD cases were also associated with higher probability of epinephrine (OR: 2.05, CI: 1.33–3.15,  $p < 0.001$ ) and sodium bicarbonate administration (OR: 2.70, CI: 1.98–3.68,  $p < 0.001$ ). Other variables did not differ. **Conclusion.** Patients with OD-related OHCA were more likely to receive resuscitation drugs, receive higher CPR fraction, and survive than non-OD OHCA cases.

#### 108. THE TIMING OF PREHOSPITAL INITIATION OF THERAPEUTIC HYPOTHERMIA INTRA-ARREST VERSUS POSTARREST: A RANDOMIZED CONTROLLED TRIAL

Jonathan Studnek, John Garrett, Steve Vandever, David Pearson, Mecklenburg EMS Agency

**Background.** This study assessed the frequency of return of spontaneous circulation (ROSC) and survival to hospital discharge among patients experiencing out-of-hospital cardiac arrest (OOHCA) randomized to receive either intra-arrest therapeutic hypothermia (IATH) or postarrest therapeutic hypothermia (TH). **Methods.** This was a single-center randomized controlled trial performed in a municipal emergency medical services agency from September 1, 2011, to May 31, 2012. Patients were included in this study if they had a nontraumatic OOHCA and were >18 years of age. All arrest rhythms were randomized to a treatment arm. Patients were randomized to induction of therapeutic hypothermia via 4°C normal saline (NS) bolus in two arms: intra-arrest versus postarrest following ROSC. Those patients

randomized to the postarrest arm received a room-temperature saline bolus immediately upon intravenous/intraosseous access. During the arrest period, no patient received greater than 1,000 mL of NS. If ROSC occurred, patients received up to 2,000 mL of 4°C NS bolus. The primary outcome of this study was survival to hospital discharge with a secondary outcome of ROSC. Data analysis consisted of descriptive statistics with chi-square analysis. **Results.** There were 356 patients enrolled in this study with 13 (4.6%) excluded because of protocol violations or unknown outcome. Overall, 150 (43.0%) patients achieved prehospital ROSC and 34 (9.7%) patients survived to hospital discharge. Patients were distributed equally between study arms, with no difference in demographic or arrest characteristics. There was no significant difference in ROSC or survival to hospital discharge based on the timing of prehospital initiation of TH. Of those patients who achieved ROSC, 75 (50%) received IATH and 75 (50%) received postarrest TH;  $p = 0.89$ . This lack of difference persisted when assessing survival to discharge, with 17 (50%) patients surviving in the IATH group and 17 (50%) in the postarrest group;  $p = 0.97$ . There were 59 patients who were witnessed by a bystander and presented in ventricular fibrillation, with 16 (27.1%) surviving to discharge and 10 (62.5%) of those in the postarrest group;  $p = 0.11$ . **Conclusion.** In this randomized controlled trial, the timing of prehospital initiation of TH was not associated with improved outcome. A multicenter non-inferiority study is needed to validate these results.

#### 109. REGIONAL VARIATION OF OUT-OF-HOSPITAL CARDIAC ARREST (OHCA) SURVIVAL: DEFINING MEDICALLY UNDERSERVED AREA FOR OHCA

Won chul Cha, Jung Eui Rhee, Yu Jin Kim, Suk Ran Yeom, Sun Hyu Kim, Hyun Ho Ryu, Samsung Medical Center

**Background.** Out-of-hospital cardiac arrest (OHCA) outcome varies greatly even among adjacent communities. In this study, we aimed to evaluate regional characteristics as independent factors influencing outcome of regional OHCA survival. **Methods.** We used the national OHCA cohort database from 2006 to 2008. We included emergency medical services (EMS)-assessed cardiac arrest with presumably cardiac origin in Gyeonggi-Province. Utstein factors were extracted from the OHCA database. The study region has 10 million residents in 31 counties. One hundred nineteen ambulances provide sole, single-tiered prehospital service, which is based on the fire department. Ambulances are staffed with emergency medical technician (EMT)-Intermediates and EMT-Basics. We performed a multivariate analysis with two regional factors (population density and presence of high-volume center) along with Utstein factors predicting survival of OHCA victims. **Results.** Overall, 8,347 cardiac arrests were included for the study. The median age of the patients was 68 years (interquartile range [IQR]: 53–78), and 3,113 (37.3%) were female. Of the cardiac arrests, 7.50% occurred in public places; 43.7% were witnessed, but only 2.40% received bystander CPR; and 4.79% showed an initial shockable rhythm. The median response interval was 7 minutes (IQR: 5–9). The rate of ROSC was 19.6%, and the rate of survival to discharge was 3.04%. There was significant variation in the rate of survival to discharge among counties from 0.0% to 7.2% (IQR: 0.7–2.7). The multivariate logistic regression predicting survival to discharge revealed an odds ratio (OR) of 1.031 (95% confidence interval [CI]: 1.007–1.055) for

every 1,000 increment of population density. The adjusted OR for the presence of emergency centers was 1.69 (95% CI: 1.24–2.33), even after adjustment for destination hospital level and transport time. However, when put together in the regression model, only presence of emergency centers showed significant association (1.56; 95% CI: 1.08–2.25) due to strong interaction ( $p < 0.001$ ) between emergency centers and population density. **Conclusion.** Survival of OHCA patients varied significantly even among adjacent counties. Low population density along with absence of a low-volume center can be used to define medically underserved areas for OHCA.

#### 110. EFFECT OF THE 2010 GUIDELINES ON TIME TO DRUG ADMINISTRATION DURING RESUSCITATION AND OUTCOMES FOR OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS

Leticia Huynh, David Salcido, Allison Koller, James Menegazzi, University of Pittsburgh School of Medicine Department of Emergency Medicine

**Background.** The American Heart Association (AHA) 2010 Advanced Cardiac Life Support (ACLS) Guidelines placed new emphasis on the importance of rapid time to drug administration, moving vascular access in front of advanced airway management in the suggested order of interventions. We hypothesized that there would be a decrease in time to drug administration following publication of the 2010 AHA Guidelines and an increased proportion of intraosseous (IO) access utilization. We also hypothesized that improved patient outcome markers would be associated with decreased time to drug administration. **Methods.** We performed a retrospective analysis of data for cardiac arrest patients who were registered in a single Regional Clinical Center of the Resuscitation Outcomes Consortium (ROC) database between November 2006 and April 2011. Using Microsoft Excel and STATA12, we tracked mean time to drug administration on a monthly basis and proportion of IO vs. intravenous (IV) drug administration. We used two-tailed *t*-tests and chi-square tests to compare pre- and post-guideline data. We also tracked patient survival and Modified Rankin Scale (MRS) score and performed multiple logistic regression analyses in order to assess the association between time to drug administration and outcome variables. **Results.** We analyzed 1,685 cases (1,321 cases before and 364 cases after publication of the Guidelines). The mean time to drug administration before Guidelines publication was 10.17 (6.19) minutes and after publication was 10.16 (5.84) minutes, with  $p = 0.93$ . The proportion of cases involving IO access only before Guidelines publication was 0.09 and after publication was 0.31, with  $p < 0.001$ . The proportion of cases involving both IO and IV did not change significantly after Guidelines publication. Logistic regression results indicated that each additional minute between arrival and drug administration resulted in an 8% decrease in survival probability with  $p = 0.002$ . There was no association between time to drug administration and MRS score. **Conclusions.** In this ROC Regional Center, there was no decrease in time to drug administration after publication of the Guidelines. However, time to drug administration was already fairly rapid prior to publication of the Guidelines. There was a significant increase in proportion of cases using IO access after Guidelines publication, with IO use more than doubling. Additionally, we found time to drug administration to be a significant predictor of survival, but not of MRS score.

#### 111. DOES PREHOSPITAL CONTINUOUS POSITIVE AIRWAY PRESSURE IMPACT THE RATE OF INTUBATION AND MORTALITY OF ACUTE RESPIRATORY EMERGENCIES?

Sheldon Cheskes, Linda Turner, Sue Thomson, Nawfal Aljerian, Sunnybrook Centre for Prehospital Medicine

**Background.** Previous small studies have demonstrated decreased rates of intubation and mortality with prehospital use of continuous positive airway pressure (CPAP). We sought to validate these findings in a larger observational study. **Methods.** We conducted an observational study of patients transported by emergency medical services (EMS) during the 12 months before and the 12 months following implementation of a prehospital CPAP protocol for acute respiratory distress. This 24-month consecutive period ended June 24, 2010. Included were all patients transported by EMS meeting preestablished criteria indicative of acute respiratory distress and CPAP use (patient's problem specified as cardiac, respiratory distress, respiratory disease, or congestive heart failure [CHF]); age = 12 years; chest sounds documented as wheezes or rales; Glasgow Coma Scale score = 11; respiratory rate = 24 breaths/min; systolic blood pressure = 90 mmHg; oxygen saturation <90%). Data were abstracted from ambulance call reports (ACRs) and hospital records. All cases in which a do-not-resuscitate (DNR) order was documented on the patient chart or ACR or whose in-hospital outcome (death or discharge) was unknown were excluded. **Results.** In all, 442 patients met the above criteria. The mean ( $\pm$  standard deviation) age was 73.0 ( $\pm$ 13.9) years, and 51.5% were women. The in-hospital mortality rates did not differ for these patients: 17 of 228 (7.5%) in the "before" group and 17 of 214 (7.9%) in the "after" group ( $p = 0.72$ ,  $\beta$  0.60 to find an absolute difference of 6%). Although lacking power for statistical significance, an analysis of the subgroup that had a hospital diagnosis of chronic obstructive pulmonary disease (COPD), CHF, or pulmonary edema ( $n = 273$ ) showed that mortality was lower in the "before" group (3/138, 2.2%) than in the "after" group (8/135, 5.9%) (Fisher's exact test,  $p = 0.13$ ). No patients in either group were intubated in the prehospital setting, and in-hospital intubation rates were similar for both groups (11.6% vs. 9.7%; chi-square = 0.26,  $p = 0.61$ ). **Conclusion.** In contrast to previous studies, we were unable to demonstrate either a decrease in intubation or mortality related to the use of prehospital CPAP. Our findings may be specific to our EMS system but suggest that further large-scale randomized controlled trials may be warranted to firmly establish the benefit of prehospital CPAP.

#### 112. A BEFORE-AFTER STUDY TO EVALUATE THE EFFECTIVENESS AND USEFULNESS OF PREHOSPITAL NONINVASIVE VENTILATION IN AN URBAN SETTING

Andrew Willmore, Richard Dionne, Ian Stiell, University of Ottawa

**Background.** Noninvasive ventilation (NIV) is commonly used in the treatment of acute decompensated heart failure (CHF) and chronic obstructive pulmonary disease (COPD) exacerbations. In-hospital evidence is robust: NIV has been shown to improve respiratory status and reduce intubation rates. There is less evidence on prehospital NIV, although emergency medical services adoption of this modality is increasing. The objectives of this study were as follows: 1) to measure the impact of prehospital NIV on morbidity, mortality, and transport times; and 2) to audit the selection of

patients by medics for appropriateness and safety. **Methods.** We conducted a before–after study from August 1 to October 31 in 2010 and 2011, before and after the implementation of prehospital NIV in a city of 1 million people with large rural areas. Medics were trained to apply NIV to patients with respiratory distress and a presumed diagnosis of CHF or COPD. Charts were selected using the search criteria of chief complaint of shortness of breath, emergent transport to hospital, and receipt of NIV in the field. Data were extracted from ambulance and hospital records and were analyzed with appropriate univariate statistics. **Results.** We enrolled 373 patients (186 in the pre-NIV group, 187 in the post-NIV group), with mean age 71.5 years, female 51.4%, and final diagnoses of CHF 18.9%, and COPD 21.9%. Characteristics and transport times were similar between groups. In the post-NIV group, of 84 patients meeting NIV criteria, 41.6% actually received it; of 102 patients not meeting criteria, 5.2% received NIV. There were 12 adverse events documented from a total of 36 NIV applications (33.3%), all of them minor. Comparing the post-NIV with the pre-NIV groups, there were higher rates of ED NIV administration (20.0% vs. 13.4%,  $p < 0.0001$ ) and higher overall mortality (18.8% vs. 14.9%,  $p < 0.0001$ ). There was no difference between groups in rates of ED intubation (2.1 vs. 2.3%,  $p < 0.001$ ) or hospital length of stay (6.8 vs. 8.7 days,  $p = 0.24$ ). **Conclusion.** NIV was applied to a relatively small proportion of patients meeting criteria. No patient safety issues were identified. With respect to morbidity, mortality, and hospital length of stay, prehospital NIV failed to show benefit in this urban setting.

#### 113. THE PREHOSPITAL ADMINISTRATION OF STEROIDS IN MODERATE TO SEVERE ASTHMA AND COPD EXACERBATIONS DOES NOT REDUCE PATIENT ADMISSIONS

**Andrew Stevens, Chelsie Baughman, Michael Daum, Mary Ann Kozak, Bruce Tilson, Dan O'Donnell, Indiana University School of Medicine**

**Background.** Asthma and chronic obstructive pulmonary disease (COPD) exacerbations are a common reason for emergency medical services (EMS) activations. A small set of literature suggests decreased admission in asthma patients given steroids prehospital. These studies were limited by sample size and included only asthma. To our knowledge, no research exists examining the effect of prehospital steroids on asthma and COPD exacerbations. We hypothesized that prehospital utilization of steroids in asthma and COPD patients reduces hospital and intensive care unit (ICU) admissions. **Objective.** Determine the role of systemic steroids in moderate to severe prehospital asthma and COPD exacerbations. **Methods.** We performed a before-and-after observational two-group cohort study. This study was conducted using a large urban EMS system with patients transported to two academic medical centers with over 100,000 emergency department (ED) visits per year. Patients were included in the study with a history of asthma or COPD and requiring  $>1$  nebulized medication or continuous positive airway pressure. Exclusion criteria were history of congestive heart failure or dyspnea attributed to other causes. Our control group was all patients not receiving steroids for the period January to July 2011. Our experimental group, conducted during the trial period, January to July 2012, included patients receiving prednisone or methylprednisolone based on new prehospital protocols implemented January 1, 2012. Primary outcome was rate of hospitalization before and after the implementation of prehospital steroids. A secondary data

point was ICU admissions. **Results.** The two groups were similar in respect to age (average 55 years), gender, race, and respective asthma and COPD histories. In our before group, 131 patients were identified and 87 (66.4%) were admitted. Of these, 25 (19.1%) were admitted to the ICU. In the after group, 66 patients were treated and 50 (75.8%) were admitted. Of these, seven (10.6%) were admitted to the ICU. The overall admission rate before and after increased 9.4% ( $p = 0.179$ ), with a non-ICU admission rate increase of 17.9% ( $p = 0.019$ ). The ICU admission rate decreased 8.5% ( $p = 0.127$ ). **Conclusion.** Patients with moderate to severe asthma and COPD exacerbations receiving prehospital steroids have increased hospitalization but lower ICU admission. This may be attributable to prehospital providers' identifying patients with more severe conditions as needing steroids and the intervention's decreasing the need for intensive care.

#### 114. BLOOD IS BLOOD: VALIDATION OF SCAPULAR CAPILLARY BLOOD GAS (ScapGAS) SAMPLING TO DETERMINE SERUM pH

**William Bozeman, Patti Kriegel, Jenny Kneezel, Christine Hall, Wake Forest University School of Medicine**

**Background.** Assessment of metabolic status by measurement of serum pH is essential in many critically ill patients. However, standard arterial blood gas (ABG) analysis sampling can be hazardous or impossible in combative or seizing patients, and is typically unavailable in the EMS setting. Capillary blood gas sampling is a validated alternative method to standard ABG sampling that is commonly employed in pediatric populations. Scapular region capillary blood gas (ScapGas) sampling is easily performed in restrained but uncooperative adults in the hospital or prehospital setting, and has previously been validated in healthy volunteers. **Methods.** A prospective controlled trial was performed to determine whether the pH measured by analysis of ScapGas samples was in clinical agreement with the pH on standard ABG samples. Subjects were adult emergency department patients who received ABG analysis as part of their clinical care. Samples were obtained within 5 minutes of each other; point-of-care (POC) analysis was performed. Clinically acceptable agreement was defined a priori as pH values within  $\pm 0.05$  of each other. **Results.** Forty-one patients with matched pairs of ScapGas and standard ABG samples were enrolled. The mean difference in pH was 0.022 (standard deviation [SD] 0.043, 95% confidence interval 0.009–0.036). Agreement of pH values within 0.05 was present in 33 of 41 cases (80.5%; 95% confidence interval [CI] 65.1–91.2). Lactate values were also compared in a subgroup of 15 subjects with matched pairs of lactate measurements. These were also similar between the two sampling techniques, with a mean difference of 0.39 (SD 0.40, 95% CI 0.17–0.61). **Conclusions.** ScapGas sampling and POC analysis produces pH measurements with clinically acceptable agreement compared with standard ABG sampling and analysis. This sampling technique may have utility in both hospital and prehospital settings to determine serum pH and guide clinical care in combative or uncooperative patients.

#### 115. DO ADULT PATIENTS HAVE MORE PREHOSPITAL DATA REPORTED THAN CHILDREN?

**Lara Rappaport, Jesse Hawke, Joseph Darmofal, Kathleen Adelgais, Children's Hospital Colorado**

**Background.** The Institute of Medicine Emergency Services Report and guidelines developed by the American College of Surgeons ad-

vised that triage should begin with measurement of vital signs (VS). Local and state emergency medical services (EMS) pediatric protocols indicate VS measurement and monitoring for many common conditions. Previous studies have demonstrated that incomplete VS monitoring during prehospital care is common in children with acute illness and injury such as trauma and traumatic brain injury (TBI). **Objective.** The purpose of this study was to compare rates of obtaining prehospital VS data (oxygen saturation, blood pressure [BP] monitoring, heart rate [HR], respiratory rate [RR], capnography, and Glasgow Coma Scale [GCS] scoring) and intravenous (IV) line placement attempts between adults and children. **Methods.** Emergency medical services (EMS) records from 2010 to 2011 were extracted from the Online Matrix system in the Colorado State Reported EMS system and analyzed. Records were excluded for the following reasons: no treatment required, scene refusal, or call canceled. Outcome measurements were proportions of adults and children (defined as  $<15$  years) with the following: IV placement, HR, BP, RR, oxygen saturation, GCS score, and capnography monitoring. Comparisons between age groups and between the state's 11 Regional Emergency Medical and Trauma Advisory Councils (RETACs) using  $\chi^2$ . **Results.** During the study period, there were 475,501 patient encounters (adult: 445,883, pediatric: 29,618). The proportions of patients with HR, RR, BP, and oxygen saturations were similar between adult patients and pediatric patients (48% vs. 52%). There were lower rates of GCS scoring and capnography among both adults and children, with no notable differences between age groups. Significant variation was found between regions, with some reporting VS in  $>85\%$  of patients and others as low as 10%. Placement of IV was higher in adults compared with children (30% vs. 12%,  $p < 0.0001$ ). **Conclusions.** There was no significant difference between adults and children in VS monitoring in the state of Colorado; however, there was a difference in the proportion of patients with IV placement. There were significant variations between the geographic regions. Further studies are needed to assess factors associated with this large variation as well as the large number of missing VS among patients transported by prehospital providers.

#### 116. A NOVEL PEDIATRIC WEIGHT ESTIMATION TOOL FOR EMS PROVIDERS

**Ryan Jacobsen, Jennifer Watts, Susan Abdel-Rahman, Tiffany Hefner, Donna O'Malley, Stacey Doyle, M. Dowd, Kansas City, Missouri, EMS/Truman Medical Center**

**Background.** When caring for children in the out-of-hospital environment, accurate and rapid weight estimation is critical. A novel weight-estimation method based on humeral length and mid-upper arm circumference (Mercy method) was recently developed. This study was designed to evaluate the accuracy, precision, and speed of two Mercy method-based devices (two-dimensional tape [2DT], three-dimensional tape [3DT]) compared with five other weight-estimation methods (provider estimate [PE], Advanced Pediatric Life Support [APLS], Broselow tape [BT], Devised Weight-Estimation Method [DWEM], and Luscombe and Owens [LO]) when used by prehospital providers. **Methods.** Emergency medical services (EMS) providers were recruited for this prospective study from five regional EMS agencies. Each provider applied all seven weight-estimation methods, in random order, to five children of varying ages

and weights. The speed with which the measures were performed was recorded in seconds. Actual weight was determined using a calibrated scale. Accuracy was assessed by mean error (ME), calculated as predicted minus actual weight (kg), and mean percentage error (MPE), calculated as ME divided by actual weight  $\times$  100. Percentages of estimates within 10–30% of actual weight were also determined. **Results.** Thirty-six EMS providers (15 emergency medical technician [EMT]-Basic, 21 EMT-Paramedic) participated; they were 37.4  $\pm$  9.5 years of age and had 12.8  $\pm$  8.9 years of experience. The children averaged 7.3  $\pm$  4.7 years of age, measured 123.1  $\pm$  32.6 cm and weighed 31.8  $\pm$  20.8 kg, and represented all five body mass index (BMI) percent categories. Mean method speeds (seconds) were as follows: PE (27.3  $\pm$  14.5); APLS (15.7  $\pm$  13.2); BT (43.1  $\pm$  18.9); DWEM (50.7  $\pm$  17.2); LO (15.2  $\pm$  6.8); 2DT (68.1  $\pm$  21.4); and 3DT (63.1  $\pm$  23.6). ME for each method: PE (0.1); APLS (–9.2); BT (–4.4); DWEM (–3.7); LO (–2.7); 2DT (–1.0); and 3DT (–2.3). MPE (%) for each method: PE (4.1); APLS (–18.7); BT (–7.2); DWEM (–6.1); LO (1.5); 2DT (–0.6); and 3DT (–6.1). Percentages of estimates within 10%, 20%, and 30%, respectively, of actual weight: PE (22, 42, 66); APLS (24, 41, 62); BT (44, 69, 84); DWEM (37, 74, 83); LO (33, 68, 80); 2DT (51, 75, 89); and 3DT (44, 73, 90). **Conclusion.** The 2DT and 3DT, while slower, appear to provide accurate weight estimation. Performance in an emergency setting and/or with additional provider training needs to be evaluated.

#### 117. CONTINUOUS CHEST COMPRESSION—CARDIOCEREBRAL RESUSCITATION IN NONPRIMARY CARDIAC ARREST

Jennifer Kimbrell, Joseph Salomone, *Emergency Physicians of Springfield*

**Background.** Continuous chest compression—cardiocerebral resuscitation (CCC-CCR) protocols have shown improved return of spontaneous circulation (ROSC) and survival for primary out-of-hospital cardiac arrest (OOHCA). Our protocol emphasizes continuous chest compressions and passive oxygenation, and previous reports demonstrated its efficacy. There are no reports for CCC-CCR protocols for nonprimary cardiac arrest (NPCA) patients. **Objective.** To describe the effect of a CCC-CCR protocol on ROSC and survival to hospital discharge for nonprimary OOHCA compared with a historical cohort. **Methods.** A retrospective, observational cohort extracted from the emergency medical services (EMS) cardiac arrest database was reviewed to identify all adult (18 years and older), nontraumatic, and nonprimary cardiac arrests from July 2008 through June 2010 (CCC-CCR) and compared with data from our EMS system using the previous standard cardiopulmonary resuscitation (CPR) from January 2003 to March 2006 (standard). Examples of NPCA classes were gastrointestinal bleeds, respiratory arrests, and toxic ingestions. Our system is a Midwest, urban, all-advanced life support ambulance service with basic life support fire department first response. **Results.** Overall, there were a total of 203 and 156 NPCA patients in the standard and CCC-CCR cohorts, respectively. The ROSC rates for ventricular fibrillation/ventricular tachycardia (VF/VT) were 28.6% ( $n = 2/7$ ) standard and 28.6% ( $n = 4/14$ ) CCC-CCR, relative risk (RR) 1.0, 95% confidence interval (CI) 0.24–4.20,  $p = 1.00$ . The survival rates for VF/VT were 0% ( $n = 0/7$ ) standard and 28.6% ( $n = 4/14$ ) CCC-CCR, RR 0.0, 95% CI 0.0–infinity,  $p = 0.255$ . The ROSC rates for pulseless electrical activity (PEA) were 34.3%

( $n = 49/143$ ) standard and 38.9% ( $n = 21/54$ ) CCC-CCR, RR 1.22, 95% CI 0.64–2.33,  $p = 0.617$ . The survival rates for PEA were 10.5% ( $n = 15/143$ ) standard and 18.5% ( $n = 10/54$ ) CCC-CCR, RR 1.91, 95% CI 0.80–4.56,  $p = 0.155$ . The ROSC rates for asystole were 18.9% ( $n = 10/53$ ) standard and 14.8% ( $n = 13/88$ ) CCC-CCR, RR 0.75, 95% CI 0.30–1.84,  $p = 0.639$ . The survival rates for asystole were 1.9% ( $n = 1/53$ ) standard and 0% ( $n = 0/88$ ) CCC-CCR, RR not applicable, 95% CI 0–infinity,  $p = 0.376$ . There was no significant difference in mean age, bystander CPR, gender, or response time. **Conclusion.** This was a retrospective cohort study with all of the inherent limitations. This cohort was obtained from a single EMS system. The data pool was small, thus the study was underpowered. There were no differences in ROSC or survival for patients treated with the standard protocol versus the CCC-CCR protocol. Further investigation of NPCA is needed.

#### 118. AMBULANCE PATIENTS ARE MORE (OR LESS) LIKELY TO BE INSURED

Jeffrey Dixon, Annette Arthur, Emily Williams, Jeffrey Goodloe, Stephen Thomas, *University of Oklahoma*

**Background.** Ambulance diversion, which is increasing in some emergency medical services regions, has a number of known disadvantages. From the hospital perspective, one potential disadvantage that may differ in varying regions is the loss of patients who are more likely to be insured. If patients arriving to the emergency department (ED) by ambulance are less likely to be uninsured (“self-pay”) than nonambulance patients, ED leaders can use this information to lobby for resources needed to avoid diversion. The purpose of this study was to determine whether, for a single ED, ambulance patients were more (or less) likely to be uninsured as compared with nonambulance patients. **Methods.** An administrative database from January 2011 through March 2012 was used from the study center (700-bed teaching hospital ED with annual census roughly 50,000) to assess numbers of patients and mode of arrival to the ED. No other information was assessed and no identifiers were assayed. Binomial exact 95% confidence intervals (CIs) were calculated for the proportion of uninsured patients in the ambulance and nonambulance cohorts. The statistical association between arrival mode (ambulance versus nonambulance) and dichotomous insurance status was conducted using chi-square testing and the cohort study epidemiology function in STATA 12MP (StataCorp, College Station, TX). The measure of relative risk was the risk ratio (RR), reported with 95% CI. **Results.** For the 15-month study period, there were 18,072 ambulance patients and 58,594 nonambulance patients. The overall proportion of noninsured status for ambulance patients was lower than the proportion of noninsured status for nonambulance patients. For ambulance cases, the uninsured rate was significantly ( $p < 0.0001$ ) lower than for nonambulance cases: 23.4% (95% CI 22.8% to 24.0%) versus 28.7% (95% CI 28.2% to 29.0%). Ambulance cases were nearly 20% less likely to be uninsured (RR 0.82, 95% CI 0.79 to 0.84,  $p < 0.0001$ ). **Conclusion.** For the specific hospital studied, ambulance patients were significantly less likely than nonambulance patients to be uninsured. These data are being used in ongoing conversations with hospital administration regarding providing the ED with sufficient resources to avoid diversion status. Other centers may benefit from performance of similar analysis.

#### 119. RELATIVE INFLUENCE OF DIFFERENT STRESSES ON PTSD IN A CANADIAN EMS SERVICE

Elizabeth Donnelly, Paul Bradford, Randy Mellow, Cathie Hedges, Peter Morassutti, *University of Windsor*

**Background.** Emergency medical services (EMS) providers are regularly exposed to a variety of stressors endemic to the profession, all of which may contribute to stress reactions such as posttraumatic stress disorder (PTSD). These stressors may be related to the provision of patient care (critical incident stress), the organization and the culture in which the responder is working (organizational stress), or the stresses associated with working on an ambulance (operational stress). Previous research has identified a relationship between operational stress, organizational stress, critical incident stress, and PTSD; however, it is unclear whether this relationship persists in the Canadian context. The objective of this study was to investigate how different types of occupationally related stress may contribute to stress reactions for paramedics working in a county-based service in southwest Ontario. **Methods.** All paramedics in a municipally operated service (annual call volume 80,000) were invited to complete a 167-item online survey examining self-reported levels of operational stress, organizational stress, critical incident stress, posttraumatic stress symptomatology (PTSS), and demographic characteristics. Pearson correlation coefficients were used to estimate linear dependence between stress variables. Ordinary least-squares regression determined predictor variables independently associated with PTSS. **Results.** One hundred forty-five paramedics (a 54% response rate) completed the questionnaire. Analysis revealed a significant relationship between operational stress ( $r = 0.508$ ;  $p < 0.001$ ), organizational stress ( $r = 0.419$ ,  $p < 0.001$ ), and critical incident stress ( $r = 0.433$ ,  $p < 0.001$ ) and PTSS. When controlling for demographic factors, operational stress was independently associated with PTSS ( $p < 0.001$ ); an interaction effect between operational stress and critical incident stress ( $p = 0.001$ ) created a robust final model with an  $R^2$  of 0.391. **Conclusion.** In the Canadian context, exposure to a multiplicity of stressors increases the risk of paramedics’ developing a posttraumatic stress reaction. Operational stress independently increases the risk for a posttraumatic stress reaction; critical incident stress interacts with operational stress to further exacerbate the risk. These findings indicate that health and wellness initiatives should address the impact of both critical incident stress and chronic work-related stress. Further, these findings illustrate the need for the development and validation of evidence-based interventions addressing the multiplicity of factors that can contribute to the development of stress reactions in paramedics.

#### 120. EMS HELICOPTER EFFECTIVENESS: CAN AUTO-DISPATCH IMPROVE EFFECTIVENESS WHILE MAINTAINING APPROPRIATE UTILIZATION OF EMS FLIGHT SERVICES?

Noel Wagner, Philip Sloan, *CMU Healthcare*

**Background.** It is well known that decreasing the time from injury to definitive care correlates with a decrease in adverse outcomes for trauma patients. Several changes have been implemented over the past several decades that have been aimed at decreasing this time. The use of emergency medical services (EMS) scene flights for trauma is one change that has been successful in minimizing time to arrival at definitive care. Despite this success, there are

still areas in the typical EMS notification, dispatch, and response system where adjustments can be made for further benefit. Our study focuses on the time required to initiate the dispatch of flight services to trauma scenes and criteria that can be used to simultaneously dispatch both ground EMS and flight services to those scenes where potential exists for injuries that require rapid transport to definitive care facilities. We theorize that by using prearranged criteria, dispatchers can simultaneously dispatch these complementary services to appropriate scenes, resulting in more prompt EMS flight arrival and a shorter time to definitive care without resulting in an increased number of unnecessary EMS flights. **Methods.** We put in place a set of criteria that would prompt dispatch to initiate simultaneous launch of ground and flight EMS units. These criteria were activated on January 1, 2011. In a retrospective review of records, data were collected from January 1, 2010, to December 31, 2010, and from January 1, 2011, to December 31, 2011. The data were organized into several time intervals (call–dispatch, dispatch–arrival, etc.) and compared to evaluate the effect of the autolaunch protocols. Times were averaged for the separate periods and compared using t-test for statistical significance. **Results.** Fifty percent of the 2011 flights met autolaunch criteria. The average time lapse from call to flight dispatch was decreased by 3 minutes ( $p = 0.025$ ). There was no significant decrease in overall injury severity of patients transported (Glasgow Coma Scale score;  $p = 0.307$ ) (Revised Trauma Score;  $p = 0.748$ ). There was not significant change in the number of canceled flights ( $p = 0.499$ ). **Conclusions.** Autolaunch criteria can successfully be used to simultaneously dispatch ground and flight EMS units without significant overutilization of flight EMS. Future studies may aid in identifying other areas of the typical dispatch procedure where further time-saving protocols can be initiated.

#### 121. DEVELOPING A DYNAMIC RESTATIONING AMBULANCE MODEL AND PILOT STUDY

Yu Jin Lee, Won Chul Cha, Ki Jeong Hong, Chu Hyun Kim, Kyoung Jun Song, Sang Do Shin, *Researcher*

**Background.** Since requests for ambulance service are increasing every year, it is becoming more difficult to sustain the appropriate response interval. Moreover, difference of workload among ambulance teams is making it more difficult to keep the appropriate service level. In this study, we aimed to test a new dispatch system with computer simulation, and then validate it. **Methods.** This was a before-and-after study, comparing the stationing model of ambulances. The study area was a rural area with small town in the center. The size was about 353 km<sup>2</sup> with a population of 190,000. There were four stations and six ambulances dispatched by a centralized dispatch center in a single-tiered system. Each ambulance had a fixed base. First, we developed a dynamic restationing strategy by which ambulances do not have a fixed station. When any of four stations became empty, available ambulances were restationed to fill the positions. After testing the strategy with discrete event simulation, we performed an in vivo test from September 15 to October 29, 2010. Ambulance log data such as call time, start time, scene arrival time, hospital arrival time, and back time were extracted to measure outcome values. The control phase comprised the same dates in 2009. The primary outcome was cases with coefficient of variation (CV), which means discrepancy of workload among ambulances. The secondary outcome was average response interval. **Results.** A total of 1,751 cases were collected: 896 cases

during the study phase and 855 cases during the control phase. The mean age of the patients was 48.4 years ( $p = 0.79$ ), and 61.0% were male ( $p = 0.22$ ). The mean response time was 10.6 minutes (standard deviation [SD] = 6.5) in the study phase and 10.1 minutes (SD = 6.3) in the control phase ( $p = 0.16$ ). The CV decreased from 0.35 to 0.15. In the same period of 2009, the mean transfer rate was 3.4 cases/day (SD = 1.2) and the CV was 0.35, and the mean work time was 3.9 hours/day (SD = 0.68) and the CV was 0.17. In the pilot study period, the mean transfer rate was 3.6 cases/day (SD = 0.2) and the CV was 0.06, and the mean work time was 3.5 hours/day (SD = 0.1) and the CV was 0.03. **Conclusion.** It is significant that this new restationing strategy was effective to equalize workload while keeping the same response time.

#### 122. MEASURING THE QUALITY OF EMERGENCY MEDICAL SERVICES CARE USING COMPOSITE SCORES

Patrick Chow-In Ko, Yi-Cheng Lu, Fen-Ru Chen, Wen-Chu Chiang, Matthew Huei-Ming Ma, Tsung-Tai Chen, *National Taiwan University Hospital*

**Background.** Policymakers may need to rate the quality of emergency medical services (EMS) in terms of its performance. However, the quality of health care is usually a multi-dimensional construct that may not be measured directly. Thus, multiple indicators are used to construct a composite score for quality measurement. We investigated the association between the different composite scores derived from EMS process measures and discharge mortality. **Methods.** Data were collected from an urban out-of-hospital cardiac arrest (OHCA) registry from the period January 1, 2006, to December 31, 2009. The composite scores in our study were derived from the following two methods: 1) the raw sum score and 2) the all-or-none score. These composite scores of each EMS ambulance team were calculated based on two process measures (EMS response time <5 minutes and achieving prehospital return of spontaneous circulation [ROSC]). Finally, the association between the composite scores and the risk-adjusted discharge mortality was investigated using a mixed-effects model. **Results.** A total of 4,000 adult non-trauma OHCA patients resuscitated and transported by 44 EMS ambulance teams were analyzed. The all-or-none score of the EMS ambulance team demonstrated a highest inverse relationship with risk-adjusted discharge mortality ( $-0.85$ ,  $p < 0.01$ ) compared with the raw sum score and the individual process measure of the EMS ambulance team. The two process measures (EMS response time <5 minutes and achieving prehospital ROSC) showed lower inverse relationships with risk-adjusted discharge mortality ( $-0.39$  and  $-0.76$ , respectively). **Conclusions.** Applying the composite scores, especially the all-or-none score, to measure the quality of care for EMS ambulance teams shows higher validity. Thus, the composite scores constructed by a number of EMS process measures may be utilized as an alternative approach to access and evaluate EMS quality and performance.

#### 123. RESCUE SHOCK TIMING AND OUTCOMES DURING THE METABOLIC PHASE OF VENTRICULAR FIBRILLATION

Ryan Coute, Timothy Mader, Scot Millay, Adam Kellogg, *Baystate Medical Center/Tufts University School of Medicine*

**Background.** To determine whether 3 minutes of cardiopulmonary resuscitation (CPR) and a single dose of epinephrine prior to the

first rescue shock (RS) are sufficient to achieve return of spontaneous circulation (ROSC) after 12 minutes of untreated ventricular fibrillation (VF). **Methods.** This was a secondary analysis of prospectively collected data from an Institutional Animal Care and Use Committee (IACUC)-approved protocol. Fifty-three Yorkshire swine (weighing 25–30 kg) were surgically instrumented under anesthesia and VF was electrically induced. After 12 minutes of untreated VF, CPR was initiated (and continued as needed [prn]) and a standard dose of epinephrine (SDE) (0.01 mg/kg) was given (and repeated every 3 minutes prn). The first RS was delivered after 3 minutes of CPR (and every 3 minutes thereafter prn). Each failed RS was followed (in series) by vasopressin (VASO [0.57 mg/kg]); amiodarone (AMIO [4.3 mg/kg]); and sodium bicarbonate (BICARB [1 mEq/kg]) prn. Resuscitation attempts continued until ROSC was achieved or 20 minutes elapsed without ROSC. The primary outcome measures were ROSC (systolic blood pressure [SBP] >80 mmHg for >60 seconds) and survival (SBP >60 mmHg for 20 minutes). Coronary perfusion pressure (CPP) values for the first two RS attempts were also calculated. Data were analyzed using descriptive statistics. **Results.** ROSC was achieved in 30 of the 53 (57%) animals. Survival occurred in 28 of the 53 (53%) animals. The mean pre-shock CPP was 27.9 mmHg (95% confidence interval [CI] 23.2–32.5) for the first RS (RS1) and 49.8 (95% CI 43.4–56.2) for RS2. ROSC occurred in one animal following RS1 (3.3%; 95% CI 0.6–16.7), 17 animals following RS2 (56.7%; 95% CI 39.2–72.6), five animals following RS3 (16.7%; 95% CI 7.3–33.6), and seven animals who received  $\geq 4$  RSs (23.3%; 95% CI 11.8–40.9). Survival was achieved in one animal following RS1 (3.6%; 95% CI 0.6–17.7), 15 animals following RS2 (53.6%; 95% CI 35.8–70.5), five animals following RS3 (17.9%; 95% CI 7.9–35.6), and seven animals who received  $\geq 4$  RSs (25%; 95% CI 12.7–43.4). **Conclusion.** Our data suggest that following 12 minutes of untreated VF, 3 minutes of CPR and one SDE may be insufficient to achieve ROSC on the first RS attempt. A longer duration of CPR and/or administration of additional vasopressors may result in more favorable conditions for successful defibrillation on the first attempt.

#### 124. IMPROVEMENT IN SURVIVAL FOR OUT-OF-HOSPITAL CARDIAC ARREST IN SINGAPORE OVER 10 YEARS

Marcus Ong, Caroline Choong, E. Shaun Goh, Benjamin Leong, Han Nee Gan, David Foo, Lai Peng Tham, Rabind Charles, Stephanie Fook-Chong, *Singapore General Hospital*

**Background.** Many efforts have been put in place to improve resuscitation for out-of-hospital cardiac arrests (OHCAs) in Singapore over the past 10 years. We aimed to study whether survival from OHCA has increased and which factors contributed to survival. **Methods.** This was a cohort study that compared OHCA cases from the Cardiac Arrest and Resuscitation Epidemiology (CARE) project (October 2001–October 2004) with those from the Pan-Asian Resuscitation Outcomes Study (PAROS) project (April 2010–June 2011). Survival outcomes were adjusted for age, gender, and history of heart disease and were expressed in terms of the odds ratio (OR) and the corresponding 95% confidence interval (CI). Differences in resuscitation efforts were expressed in terms of the p-value. **Results.** A total of 2,428 cases from the CARE data and 1,514 cases from the PAROS data were used for the analysis. New interventions introduced over the period included public-access defibrillation

(PAD), motorcycle first responders, laryngeal mask airways, intravenous epinephrine, mechanical cardiopulmonary resuscitation (CPR), and therapeutic hypothermia. Survival to admission increased from 9.0% to 15.8% (adjusted OR 3.0; 95% CI 2.1–4.2) and overall survival to discharge increased from 1.6% to 2.4% (adjusted OR 4.1; 95% CI 1.7–11.5). Utstein survival (witnessed ventricular fibrillation/ventricular tachycardia) increased from 2.5% to 8.3% (adjusted OR 7.6; 95% CI 1.8–51.5). Ambulance response times decreased from 9.0 to 7.8 minutes ( $p \leq 0.001$ ), but bystander CPR rates remained similar (19.7 vs. 21.3,  $p = 0.2$ ). Factors favoring survival included bystander CPR (OR 2.3; 95% CI 1.2–4.4), PAD (OR 11.1; 95% CI 1.2–51.6), motorcycle first responders (OR 4.6; 95% CI 1.6–11.1), ambulance defibrillation (OR 6.0 95% CI 3.5–10.7), and therapeutic hypothermia (OR 28.9; 95% CI 4.7–131.0). **Conclusion.** Survival from OHCA has increased over the past 10 years. However, more can be done to increase bystander CPR and the use of PAD and improve resuscitation efforts.

#### 125. CARDIOLOGIST INTERPRETATION OF PREHOSPITAL ECG IMPACTS ACCURACY OF EMS STEMI ACTIVATIONS

Louis Gonzales, Kayla Riggs, Frank Zidar, Robert Wozniak, Osvaldo Gigliotti, Jose Cabanas, Paul Hinchey,  
Office of the Medical Director, Austin/Travis County EMS System

**Background.** Prehospital identification of ST-segment elevation myocardial infarction (STEMI) is essential for an effective STEMI system of care. The accuracy of STEMI electrocardiogram (ECG) identification is essential to appropriate activation of the catheterization team, maintaining cardiology process commitment, and improving the performance

of emergency medical services (EMS) STEMI care. However, an important contributing factor of EMS STEMI ECG accuracy is the reliability of the cardiologist interpretation of the ECG. The objectives of this study were to define EMS ECG interpretation accuracy and describe the interventional cardiologist's interpretation of paramedic STEMI activations utilizing a regional STEMI definition. **Methods.** From February 1, 2011, to June 30, 2011, we performed a prospective study using ECGs from all paramedic STEMI activations in an urban/suburban EMS system. Paramedics utilized STEMI criteria agreed upon by the American Heart Association regional "Mission: Lifeline" workgroup. We sought to determine the accuracy of ECGs meeting STEMI criteria utilizing a panel of three interventional cardiologists blinded to the catheterization results. For each ECG, the cardiologists were asked to determine whether the activation met defined regional STEMI criteria. Data were collected for descriptive analysis and level of agreement among the three reviewers. **Results.** A total of 106 STEMI activations were included in the analysis. Two or three cardiologists determined that STEMI criteria were met for 71 of 106 ECGs (66%). In 51 cases (48%), all three cardiologists agreed that the ECG met STEMI criteria. Paramedic accuracy increased to 83% when only one or more cardiologists agreed that the ECG met STEMI criteria. Overall agreement among the three cardiologists was low ( $\kappa = 0.2562$ ; 95% confidence interval 0.1047–0.4077). **Conclusion.** We found low agreement between cardiologists when determining the accuracy of paramedic STEMI activations. Paramedic accuracy is dependent on the specific cardiologist who reviews the ECG. Further studies are needed to define an accuracy standard for EMS systems and to understand the reasons for cardiologist variation. Difficulty in defining a standard for EMS performance measurement remains.

#### 126. HIGH RATE OF UNRECOGNIZED METABOLIC SYNDROME IN YOUNG PARAMEDICS

Shalini Bobra, Michael Miedema, Ross Garberich, David Hildebrandt, Timothy Henry,  
Minneapolis Heart Institute Foundation

**Background.** The increasing prevalence of metabolic syndrome and type II diabetes is a major U.S. cardiovascular health challenge, and these conditions are frequently unrecognized. We evaluated risk factors in paramedics, a group of young adults who directly witness the devastating effects of coronary artery disease. **Methods.** Paramedics were offered free cardiovascular screening at an educational conference: a health screening questionnaire was filled out, blood pressure and waist circumference were measured, and a fasting lipid panel and glucose values were obtained. The current National Cholesterol Education Program Adult Treatment Panel III (NCEP/ATP III) criteria were used to define the components of metabolic syndrome. **Results.** Of 98 attendees, 50 young adults (median age 40.8 years, range 21–60) participated in the screening. Only four reported a history of hypertension and none had diabetes. The components of the metabolic syndrome were highly prevalent (Fig. 1), with 34 (68%) having hypertension ( $\geq 130$  beats/min systolic or  $\geq 85$  beats/min diastolic), 29 (58%) an elevated level of triglycerides, 16 (32%) an abnormal level of high-density lipoprotein (HDL), and 29 (58%) an abnormal glucose level. In total, 26 (52%) of the participants met criteria for the metabolic syndrome. Seven (14%) had a fasting glucose level  $>125$  mg/dL, potentially meeting criteria for type II diabetes, six of whom were  $\leq 41$  years old. **Conclusions.** In this sample of young paramedics,  $>50\%$  had unrecognized metabolic syndrome. More aggressive screening and education regarding healthy lifestyle choices are needed even among those frequently exposed to the cardiovascular impact of these risk factors.