

NAEMSP ABSTRACTS

ABSTRACTS FOR THE 2014 NAEMSP SCIENTIFIC ASSEMBLY

1. THE IMPACT OF PERI-SHOCK PAUSE ON SURVIVAL FROM OUT-OF-HOSPITAL SHOCKABLE CARDIAC ARREST DURING THE RESUSCITATION OUTCOMES CONSORTIUM (ROC) PRIMED TRIAL

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Background: Previous research has demonstrated significant relationships between peri-shock pause and survival to discharge from out-of-hospital (OHCA) shockable cardiac arrest. Limitations to this research include small sample sizes and limited participation by all ROC sites. We sought to determine the impact of peri-shock pause on clinical outcomes during the ROC PRIMED randomized controlled trial. **Methods:** We included OHCA patients in the ROC PRIMED trial who suffered arrest between June 2007 and November 2009, presented with a shockable rhythm, and had CPR process data for at least one shock. We excluded patients who received public access defibrillation before EMS arrival or EMS-witnessed arrest and those who had missing survival-to-hospital discharge or Utstein variable data. We used multivariable logistic regression to determine the association between peri-shock pause duration and survival to hospital discharge. **Results:** Among 2,006 patients studied (78.3% male) the median shock pause duration (IQR) was pre-shock pause 15.0 seconds (8.0, 22.0) post-shock pause 6.0 seconds (4.0, 9.0), and peri-shock pause 22.0 seconds (14.0, 31.0). In an analysis adjusted for Utstein predictors of survival (age, sex, location, bystander witnessed status, bystander CPR, arrive scene time, and ROC site) as well as CPR quality measures (compression rate, depth, and CPR fraction) the odds of survival to hospital discharge were significantly higher for patients with pre-shock pause <10 seconds (OR: 1.52, 95%CI: 1.09, 2.11) and peri-shock pause < 20 seconds (OR: 1.82, 95% CI: 1.17, 2.85) when compared to patients with pre-shock pause >20 seconds and peri-shock pause >40 seconds. Post-shock pause was not significantly associated with survival to hospital discharge. Results for neurologically intact survival (modified Rankin score = 3) were similar to our primary outcome. **Conclusions:** In patients with cardiac arrest presenting in a shockable rhythm during the ROC PRIMED trial, shorter pre- and peri-shock pauses were significantly

associated with higher odds of survival. Future cardiopulmonary education and technology should focus on minimizing all pre-shock pauses.

2. AIRWAY MANAGEMENT AND OUTCOMES AFTER OUT-OF-HOSPITAL CARDIAC ARREST IN THE CARES NETWORK

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Background: While commonly performed during out-of-hospital cardiac arrest (OHCA) resuscitation, the optimal airway management strategy [endotracheal intubation (ETI), supraglottic airway (SGA), or no advanced airway device] remains unclear. We tested the following hypotheses: 1) ETI and SGA result in similar rates of neurologically intact OHCA survival, and 2) compared with [ETI or SGA], the use of no advanced airway device results in similar rates of neurologically intact OHCA survival. **Methods:** We studied adult OHCA cases from 2011 with airway management information in the Cardiac Arrest Registry to Enhance Survival (CARES), a large multicenter North American OHCA registry. Primary exposures were 1) ETI, 2) SGA, 3) no advanced airway. Primary outcomes were 1) sustained ROSC, 2) ED survival, 3) survival to hospital discharge, 4) neurologically intact survival to hospital discharge (cerebral performance category 1-2). We defined propensity scores to characterize the probability of receiving ETI, SGA, or no advanced airway. Using multivariable random effects regression to account for clustering by EMS agency, we compared outcomes between 1) ETI vs. SGA, and 2) [no advanced airway] vs. [ETI or SGA]. We adjusted for Utstein confounders (age, sex, race, witnessed arrest, use of AED initial rhythm, public location, response time) and propensity score. **Results:** Of 10,691 OHCA, there were 5,591 (52.6%) ETI, 3,110 (29.3%) SGA, and 1,929 (18.2%) with no advanced airway. Unadjusted neurologically intact survival was: ETI 5.4%, SGA 5.2% and no advanced airway 18.6%. Compared with SGA, patients receiving ETI achieved higher sustained ROSC (OR 1.35; 95% CI 1.19-1.54), ED survival (1.36; 1.19-1.55), hospital survival (1.41; 1.14-1.76) and hospital discharge with good neurologic outcome (1.44; 1.10-1.88). Compared with [ETI or SGA], patients receiving no advanced airway attained higher ED survival (1.31; 1.16-1.49), hospital survival (2.96; 2.50-3.51) and hospital discharge with good neurologic outcome (4.24; 3.46-5.20). **Conclusions:** OHCA in the CARES network receiving no advanced airway exhibited superior outcomes than those receiving ETI or SGA. When an advanced airway was used, ETI was associated with improved outcomes compared to SGA.

3. LENGTH OF CHEST COMPRESSION PAUSES IS REDUCED WITH CARDIAC RHYTHM ANALYSIS AND CHARGING DURING CHEST COMPRESSIONS

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Background: Prolonged chest compression interruptions immediately preceding and following a defibrillation shock have been shown to reduce shock success and survival after cardiac arrest. We tested the hypothesis that compression pauses would be shorter using an AED equipped with a new Analysis During Compressions with Fast Reconfirmation (ADC-FR) technology, which features automated rhythm analysis and charging during compressions with a brief reconfirmation analysis during a compression pause, when compared with standard AED mode. **Methods:** Basic life support (BLS) certified emergency medical technicians (EMTs) worked in pairs and performed two trials of simulated cardiac resuscitation with a chest compression-sensing X Series defibrillator (ZOLL Medical). Each participant pair was randomized to perform a trial of 8 two-minute compression intervals with the defibrillator in standard AED mode and another trial in ADC-FR mode. A cardiac rhythm generator randomly assigned 4 shockable and 4 non-shockable rhythms for analysis during each compression interval. Subjects were advised to follow the defibrillator prompts, to defibrillate the rhythm if a "shock advised" was issued by the defibrillator, and to switch compressors every 2 intervals. Compression timing and quality data were reviewed using RescueNet Code Review (ZOLL Medical). Data were analyzed using paired t-tests. **Results:** Thirty-two EMT-basic prehospital providers (59% male) with a median age of 25 years (IQR 22-27) participated in the study. Chest compression interruptions at the end of each interval were significantly reduced ($p < 0.001$) for both shockable (13.5 ± 1.2 s AED vs. 9.1 ± 0.9 s ADC-FR) and non-shockable rhythms (12.1 ± 1.2 s AED vs. 7.4 ± 0.7 s ADC-FR). For shockable rhythms, pre-shock pause was reduced significantly with ADC-FR compared with AED use (7.35 ± 0.16 s AED vs. 12.0 ± 0.22 s ADC-FR, $p < 0.001$) whereas post-shock pause was similar (1.77 ± 0.14 s AED vs. 2.08 ± 0.14 s ADC-FR, $p = 0.1$). **Conclusion:** Interruptions in chest compressions associated with rhythm analysis and charging can be reduced with the use of a novel defibrillator technology, ADC-FR, which features automated rhythm analysis and charging during compressions.

4. DOES PREPARATION FOR ROC CARDIAC ARREST TRIALS IMPROVE SURVIVAL FOR THOSE INCLUDED IN THE CONTROL GROUPS?

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Background: The American Heart Association recommends biannual recertification for

advanced cardiac life support (ACLS) because skills deteriorate over time. When large cardiac arrest trials are going to begin, there is training in cardiac arrest management outside of the routine cycle, so that training occurs more frequently than biannually. The hypothesis is that more frequent training will increase survival in out-of-hospital cardiac arrest. **Methods:** All out-of-hospital cardiac arrests from the Toronto Resuscitation Outcomes Consortium Epistry between 2007 and 2012 were assessed. Patients treated between ROC cardiac arrest trials were compared to those treated in the control groups of ROC trials; paramedics would have received retraining in ACLS earlier than in their regular training schedule prior to a trial. **Results:** Patients treated in the control groups had a higher risk of death prior to hospital discharge than those treated between trials (RR 1.52; $p < 0.001$). After adjusting for age, gender, location, witnessed arrest, bystander CPR, and AED use, the odds of death were greater in those treated in the control groups of trials (OR 1.44; 95% CI 1.23-1.68; $p < 0.001$). Analysis of patients presenting with pulseless ventricular tachycardia/ventricular fibrillation yielded similar results, both by direct comparison (RR 1.35; $p < 0.001$) and after adjusting for other factors (OR 1.50; CI 1.23-1.82; $p < 0.001$). **Conclusion:** In this comparison, there was no improvement in survival to hospital discharge with more frequent training. Prospective evaluation of more frequent training and its effect on survival should be performed.

5. AN EVALUATION OF CHEST COMPRESSION FRACTION AND PERISHOCK PAUSES IN PATIENTS ENROLLED IN THE LUCAS IN CARDIAC ARREST (LINC) TRIAL

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Background: The LINC trial, described at www.sjtem.com/content/21/1/5, compared conventional cardiopulmonary resuscitation (M-CPR) with an approach that included mechanical chest compressions (LUCAS, Physio-Control, Redmond, WA) and defibrillation during ongoing compressions (L-CPR). One important aspect of CPR quality is the fraction of time a patient receives chest compressions, known as chest compression fraction (CCF). Another, perishock pause, is the total pause time surrounding shock administration. Our analysis compares CCF and perishock pauses in patients with out-of-hospital cardiac arrest (OHCA) enrolled in LINC and treated with L-CPR and M-CPR. **Methods:** The LINC trial randomized 2,589 patients with OHCA to L-CPR or M-CPR. In two of the six study sites, electronic downloads of continuous ECG and impedance data from LIFEPAK 12 monitor-defibrillators (Physio-Control) were collected. We analyzed 248 available records to determine CCF over the first 10 minutes of recorded data, and perishock pauses for all shocks. If there were fewer than 10 minutes of data, CCF was measured over the available interval. Some L-CPR recordings included a combination of initial manual CPR, deployment of LUCAS, and mechanical compressions thereafter. Therefore, the CCF for L-CPR patients was calculated in two ways, one over the first 10 minutes of recorded signals and another over the first 10 minutes after the minute when LUCAS was deployed. **Results:** Median (interquartile range) CCF was 0.785 (0.709, 0.849) for the 114 M-CPR patients, and 0.840 (0.775, 0.907) for the 134 L-CPR patients ($p < 0.0001$, Mann-Whitney U test). In patients treated with L-CPR, LUCAS was applied and mechanical compressions started within 5 minutes of the beginning of recorded signals in 119 (89%) cases. Beginning

with the minute following LUCAS deployment, the median CCF for L-CPR patients over the next 10 minutes was 0.899 (0.848, 0.938). The perishock pause was 9 seconds (6, 16) for M-CPR and 0 seconds (0, 6) for L-CPR ($p < 0.0001$). During LUCAS use, 70.4% of shocks were delivered without pausing compressions. **Conclusions:** Good chest compression fractions were achieved in both groups, indicating high-quality CPR. Furthermore, patients treated per the L-CPR protocol had a significantly higher CCF, and shorter perishock pauses, than patients treated with conventional CPR.

6. PARAMEDIC DIAGNOSTIC ACCURACY OF ST-ELEVATION MYOCARDIAL INFARCTION ON 12-LEAD ECG: A SYSTEMATIC REVIEW

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Background: In many EMS systems, physician electrocardiogram (ECG) interpretation is required to diagnose ST-elevation myocardial infarction (STEMI) in the prehospital setting. This requires time for ECG transmission and communication, and may delay time to reperfusion. The objective of this systematic review was to determine accuracy of paramedic interpretation of ECG for STEMI patients in the prehospital setting when compared to physician interpretation. **Methods:** Diagnostic studies were identified using EMBASE, MEDLINE, CINAHL, the Cochrane Review Group database, clinicaltrials.gov, hand searching bibliographies, and author contact. Studies where STEMI diagnosis by paramedics was compared against diagnoses made by non-paramedics were considered. Two authors conducted independent review for inclusion at the review of title, abstract, and full article stages, with agreement measured with kappa. Disagreement was resolved with third party adjudication. Editorials, opinions, and non-systematic reviews were excluded. Diagnostic accuracy (sensitivity, specificity, and likelihood ratios) was abstracted and reported. **Results:** Our search identified a total of 4,897 references, of which 21 met final inclusion. Interrater agreement for review of title, abstract, and full papers was 0.65 (95% CI 0.62-0.68), 0.53 (95% CI 0.47-0.59), and 0.89 (95% CI 0.82-0.97), respectively. In the included studies, there were a total of 4,784 separate ECGs read by paramedics, with 3,015 ECGs interpreted in a real-life scenario, and 1,769 interpreted in a simulation setting. The pooled sensitivity and specificity of all trials was 92.1% (95% CI 90-94.2%), and 94.7% (95% CI 93.4-96.0%), respectively, with a positive likelihood ratio of 17.4 and a negative likelihood ratio of 0.083. There was great variability among studies in the level of training of paramedics for ECG interpretation of STEMI. **Conclusion:** Paramedics are able to interpret ECGs for the diagnosis of STEMI with a high degree of sensitivity and specificity in both simulation and real-world settings. Paramedic diagnosis of STEMI on ECG greatly increases the likelihood of the presence of STEMI. Further investigation is required to determine if paramedic diagnosis of STEMI on ECG has an impact on time to definitive therapy or patient outcomes.

7. EPINEPHRINE REDUCES CAROTID BLOOD FLOW DURING CARDIOPULMONARY RESUSCITATION IN A PORCINE MODEL OF CARDIAC ARREST

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Background: Epinephrine (epi) administered during CPR improves resuscitation. However, its effect on long-term outcome is still con-

troversial. Moreover, decreases in cerebral microcirculation after epinephrine have been earlier reported in a model ventricular fibrillation (VF) cardiac arrest. We now sought to investigate the effects of epi on carotid blood flow (CBF) during CPR in a porcine model of post shock pulseless electrical activity (PEA) cardiac arrest. **Methods:** Nine domestic pigs weighing 22-24 kg were anesthetized, endotracheally intubated, and mechanically ventilated. Aortic and right atrial pressures were invasively monitored and coronary perfusion pressure (CPP) calculated. CBF was continuously monitored by a Transonic flow probe. VF was electrically induced and PEA produced by delivering electrical countershock(s). CPR, including mechanical chest compression, ventilation, and defibrillation, was then initiated and continued for 15 min. Epi (20 $\mu\text{g}/\text{kg}$) was administered into the right atrium after 2 min of CPR and repeated every 3 min thereafter. If animals were resuscitated, after 30 minutes recovery, the study sequence was repeated. **Results:** A total of 19 experimental cycles were completed with a mean of 2 ± 1 cycle/pig. CPP significantly increased from 14 ± 6 mmHg before epi to a peak of 32 ± 13 mmHg ($p < 0.01$) at 1 min after epi administration. Concurrent to CPP increases, CBF decreased from 46 ± 19 mL/min before epi to the lowest value of 22 ± 18 mL/min ($p < 0.01$) at 30 sec after epi. Both increase in CPP and decrease in CBF persisted beyond 3 min after epi. However, while CPP already decreased to 24 ± 12 mmHg, CBF persisted with a low flow of 25 ± 12 mL/min 3 min after epi. **Conclusions:** In this model, administration of epi significantly increased CPP during CPR. Increases in CPP, however, were not accompanied by increases in CBF, which was markedly reduced following epi.

8. THE IMPACT OF CHEST COMPRESSION RELEASE VELOCITY ON OUTCOMES FROM OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Previous studies have demonstrated significant relationships between CPR quality metrics and survival to hospital discharge from out-of hospital (OHCA) cardiac arrest. Recently a new metric, chest compression release velocity (CCRV), has been associated with improved survival from OHCA. The study objective was to determine the impact of CCRV on clinical outcomes from OHCA. **Methods:** We performed a retrospective review of prospectively collected data on all treated adult OHCA occurring over a one-year period (Jan 2012 – Jan 2013) in two Canadian EMS agencies. CPR metrics of chest compression fraction (CCF), compression rate, compression depth, shock pause duration, and CCRV were abstracted from impedance channel measurements during each resuscitation. Cases of public access defibrillation, EMS-witnessed arrest, and those missing any Utstein variable or discharge status data were excluded. We performed a multivariable regression analysis to determine the impact of CCRV on survival to hospital discharge. Secondary outcome measures were the impact of CCRV on return of spontaneous circulation (ROSC) and neurologically intact survival (MRS < 3). **Results:** Among 908 treated OHCA, 611 met inclusion criteria. The median (IQR) age was 71.7 (60.7, 81.6) with 395 (64.6%) being male. 140 (22.9%) presented in ventricular fibrillation, 122 (20%) pulseless electrical activity and 349 (57.1%) asystole. The median (IQR) CPR quality metrics were CCF 0.81 (0.73, 0.85), compression rate 105/minute (101, 115), compression depth 49.9 mm (42.5, 56.7), pre-shock pause 13.5 sec (8, 19), and

post-shock pause 3.5 sec (2.8, 5). The median (IQR) CCRV (mm/sec) among 49 survivors was 135.9 (115.4, 156.5) compared to 120 (102.9, 140) in 562 non-survivors ($p = 0.009$). When adjusted for CPR metrics and Utstein variables, the odds of survival to hospital discharge for each 5-mm/sec increase in CCRV was 1.02 (95% CI: 0.97, 1.08). Similarly the odds of ROSC and neurologically intact survival were 1.02 (95% CI: 0.99, 1.05) and 1.03 (95% CI: 0.98, 1.08), respectively. **Conclusions:** When adjusted for Utstein variables and CPR quality metrics, CCRV was not significantly associated with outcomes from OHCA. Our findings may have been impacted by the overall survival rate in our study cohort.

9. COMPARISON OF TWO LENGTH-BASED TAPE SYSTEMS FOR PEDIATRIC RESUSCITATION

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Background: The use of a length/weight-based tape (LBT) for equipment sizing and drug dosing for pediatric patients is recommended in a joint statement by ACS and NAEMSP. The Broselow™ tape is widely used and accepted in hospital and prehospital settings. A new system, known as Handtevy™, allows rapid determination of critical drug doses without performing calculations. Our objective was to compare two LBT systems for accuracy of dosing and time to medication administration in simulated prehospital scenarios. **Methods:** This was a randomized cross-over trial comparing the Broselow™ and Handtevy™ LBT. We enrolled ALS-certified prehospital providers (PHPs) and assessed baseline comfort level with the LBT and frequency of use. Participants performed 2 pediatric resuscitation simulations: cardiac arrest with epinephrine administration and hypoglycemia mandating dextrose. Participants repeated each scenario utilizing both LBT systems with a change in patient age to prevent memorization of dose when switching between LBTs. Facilitators recorded the time to measurement with the LBT, time to identifying the appropriate dose, and time to administration. Errors in dosing were assessed by monitoring medication preparation and the volume administered. **Results:** We enrolled 36 PHPs, performing 144 simulations. Median baseline comfort level with Broselow™ was 3 (Comfortable) compared to 1 (Not At All) for Handtevy™, and 66.8% reported using a LBT in the last year. For both epinephrine and dextrose, there was no difference in time to measurement with the LBT (17 vs. 17 seconds) or time to dose identification (44 vs. 47 seconds). For epinephrine, the LBTs were similar in time to administration (99 vs. 98 seconds) and accuracy (83% vs. 86%). Dextrose administration was faster (185 vs. 243 seconds, $p < 0.05$) and more accurate (91% vs. 34%, $p < 0.05$) with Handtevy™ compared to Broselow™. In a post-simulation survey, the majority of participants perceived the Handtevy™ system as faster (89.2%), more accurate (83.8%), and preferable (89.2%). **Conclusion:** The Handtevy™ LBT system is faster and more accurate for dextrose administration compared to the Broselow™ LBT, preserving time to administration and accuracy of epinephrine in simulated prehospital scenarios. After comparison of both systems, the majority of PHPs indicate preference for the Handtevy™ system.

10. A RANDOMIZED CONTROLLED TRIAL OF A NOVAL APPLICATION OF CHEMICAL COLD PACKS FOR TREATMENT OF EXERCISE-INDUCED HYPERTHERMIA

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Background: Heat associated illness is a common disease with significant morbidity and mortality around the world. Despite unproven efficacy, a traditional cooling technique in the prehospital environment is applying chemical cold packs (CCPs) to skin covering the large vessels of the neck, groin, and axillae. An alternative placement of CCPs to the glabrous skin surfaces that contain densely packed subcutaneous vascular structures may be more efficacious. The objective was to compare the cooling effect of CCPs applied to the neck, groin, and axillae versus glabrous skin of the cheeks, palms, and soles in exercised-induced hyperthermia. **Methods:** In this prospective randomized crossover trial, 10 healthy adult male volunteers walked on a treadmill in a heated room ($40^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$, relative humidity 20-35%) wearing insulated military overgarments. Esophageal temperature (Tes) was monitored throughout the trials. The primary stop criterion for exercise was $\text{Tes} = 39.2^{\circ}\text{C}$. The subjects then rested in the hot room for 30 minutes. Each subject participated in three heat stress trials: a no treatment trial followed by two randomly ordered cooling trials: traditional (neck, groin, axillae) or glabrous (cheeks, palms, soles). Participant trials were separated by a minimum of 2 days. **Results:** With no treatment, Tes decreased by $0.3 \pm 0.2^{\circ}\text{C}$ in the first 5 min, then stabilized for the ensuing 25 min ($R^2 = 0.007$). Traditional cooling decreased mean Tes decreased by $0.4 \pm 0.2^{\circ}\text{C}$ in the first 5 min, followed by a linear decline ($\text{?Tes} = 0.17 \pm 0.04^{\circ}\text{C}/10 \text{ min}$, $R^2 = 0.989$). Glabrous skin cooling further enhanced the treatment effect with a mean Tes decrease of $0.6 \pm 0.2^{\circ}\text{C}$ in the first 5 min of rest, followed by a steeper linear decline of $\text{?Tes} = 0.30 \pm 0.06^{\circ}\text{C}/10 \text{ min}$, $R^2 = 0.983$; $p < 0.001$. Two-way ANOVA revealed significant effects of glabrous versus traditional CCP placement at 5-30 minutes of the recovery period ($p < 0.001$). **Conclusion:** Application of CCPs to glabrous skin surfaces was more effective for treating exercise-induced hyperthermia than the traditional cooling paradigm. This novel cooling technique may be beneficial in reducing morbidity and mortality of heat illness by EMS in the prehospital environment.

11. MORTALITY AS A FUNCTION OF PREHOSPITAL SYSTOLIC BLOOD PRESSURE IN MAJOR TRAUMATIC BRAIN INJURY: WHAT IS THE OPTIMUM PRESSURE FOR SURVIVAL?

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Background: Hypotension is known to significantly increase mortality in Traumatic Brain Injury (TBI). The EMS TBI Guidelines recommend treating SBP < 90 in patients 10 years of age or older. Since most studies evaluating the association between SBP and mortality have focused nearly exclusively on hypotension, relatively little is known about the SBP range associated with optimal survival. We evaluated mortality across the entire range prehospital SBP in major TBI patients. **Methods:** All moderate/severe TBI cases (CDC Barell Matrix Type-1) in the Excellence in Prehospital Injury Care (EPIC) Study cohort of the Arizona State Trauma Registry (NIH/NINDS: 1R01NS071049; ClinicalTrials.gov-#NCT01339702) from 1/1/08 to 12/31/11 were evaluated [exclusions: age < 10 , transfers, death before ED arrival, SBP $< 10 \text{ mmHg}$, missing EMS SBP

(3.0%)]. Fractional polynomials (FP) and logistic regression (LR) were used to determine the optimal transformation for SBP across the entire range of observed values and to identify the range of SBP values associated with maximum odds of survival. **Results:** Among 4,969 included patients, FP transformation for the lowest prehospital value of SBP (SBP + SBP²) produced a linear relationship between SBP and mortality in the logit scale. An LR model with transformed SBP revealed an EMS SBP of 147 mmHg to be associated with the lowest probability of death (7.6%) with a nearly perfect inverted bell curve and remarkably tight 95% confidence intervals when mortality was plotted versus SBP across its entire range. Representative "mirror-image" low and high SBPs versus mortality are as follows: SBP = 120 mmHg or 180 mmHg (10% mortality); 110 mmHg or 190 mmHg (12%); 100 mmHg or 200 mmHg (14%); 90 mmHg or 210 mmHg (16%); 80 mmHg or 220 mmHg (20%); 70 mmHg or 230 mmHg (26%); 60 mmHg or 240 mmHg (34%); 50 mmHg or 250 mmHg (50%); 40 mmHg or 260 mmHg (63%). **Conclusions:** In this statewide, multisystem analysis of major TBI patients, an SBP between 145 and 150 mmHg was associated with the lowest mortality. The general consensus in the EMS literature and the TBI Guidelines state that SBP is only a significant clinical issue when it is very low (e.g., $< 90 \text{ mmHg}$) or very high; this may not be true. Further study is needed to identify the potential therapeutic implications of these findings.

12. WHEN SHOULD YOU TEST FOR AND TREAT HYPOGLYCEMIA IN PREHOSPITAL SEIZURE PATIENTS?

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Background: Seizure is a frequent reason for activating the emergency medical system (EMS). Little is known about the frequency of seizure caused by hypoglycemia, yet many EMS protocols require glucose testing prior to treatment. We hypothesized that hypoglycemia is rare among EMS seizure patients and that glucose testing results in delayed administration of benzodiazepines. **Methods:** This was a retrospective study of a national ambulance service database encompassing 140 EMS systems spanning 40 states and Washington, DC. All prehospital calls from August 1, 2010 through December 31, 2012 with a primary or secondary impression of seizure that resulted in patient treatment or transport were included. Data are reported using descriptive statistics along with 95% confidence intervals (CI) or interquartile ranges (IQR), as appropriate. Multivariable truncated regression with cluster (EMS agency) adjusted standard errors was used to determine if time to benzodiazepine administration was significantly related to blood glucose testing. **Results:** Of 2,052,534 total calls, 76,584 (3.7%) were for seizure with 53,505 (69.9%) of these having a glucose measurement recorded. Hypoglycemia (blood glucose $< 60 \text{ mg/dL}$) was present in 638 (1.2%; CI: 1.1, 1.3) patients, and 478 (0.9%; CI: 0.8, 1.0) were treated with a glucose product. A benzodiazepine was administered to 73 (11.4%; CI: 9.0, 13.9) of the 638 hypoglycemic patients. Overall, treatment of seizure patients with a benzodiazepine occurred in 6,389 (8.3%; CI: 8.1, 8.5) cases and treatment with a glucose product occurred in 975 (1.3%; CI: 1.2, 1.4) cases. Multivariable regression showed that obtaining a blood glucose measurement prior to benzodiazepine administration compared to no glucose measurement or glucose measurement after

benzodiazepine administration was independently associated with a 2.9-minute (CI: 2.0, 3.8) and 9.3-minute (CI: 8.3, 10.4) delay to benzodiazepine administration by EMS, respectively, controlling for age, history of diabetes, and route of benzodiazepine administration. **Conclusions:** Hypoglycemia occurs infrequently in patients treated by EMS for seizure. Glucose measurement before benzodiazepine administration was associated with a significant delay in time to benzodiazepine administration. These data suggest that benzodiazepine administration should take precedence over blood glucose determination in patients who are actively seizing. Future prospective studies are needed.

13. EMERGENCY MEDICAL DISPATCH CONSULTATION OF POISON CONTROL CENTER CAN DECREASE EMS TRANSPORTS AND CHARGES

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Background: The public commonly calls 9-1-1 for unintentional ingestions, rather than calling poison control. For ingestions in Los Angeles, the 9-1-1 dispatcher determines if an ingestion meets "omega-1" classification, meaning the ingestion is accidental, the patient is awake with normal mental status, breathing, and skin color, and the ingestion does not involve caustics, cocaine, methamphetamine, narcotics, or tricyclic antidepressants. Under such circumstances, poison control is contacted prior to dispatch of paramedics. If poison control advises that the patient can remain at home, EMS is not dispatched, and the patient is followed at home by poison control. The charge for ALS transport, excluding mileage, is \$1,750. Previous studies involving patients seeking care in an ED despite poison control recommendations to remain home have estimated the ED charges of such care to be \$1,152 per patient. The primary objective of this study was to determine the number of transports averted by involvement of a regional poison control center in overdose dispatches. A secondary objective was to estimate the potential charges saved. **Methods:** A retrospective review was performed of all overdose calls made to the Los Angeles Fire Department between 1/2008 and 6/2012. All "omega-1" calls were reviewed by a single reviewer who was blinded to the study hypothesis, after obtaining a brief instructional overview in data abstraction. Each call culminating in an EMS dispatch was subsequently reviewed by two additional reviewers. Simple descriptive statistics were utilized. **Results:** During the 54-month span, 318 cases received "omega-1" dispatch classification. EMS was dispatched 19 times (5.98%) and 11 patients (3.46%) were ultimately transported. Of the 11 transports, the most common reasons for transport were ambiguity over the ingested agent or amount and patient/family insistence. Using these charge estimates, routine consultation of poison control as part of EMS dispatch in Los Angeles was associated with an annual savings of \$200,000 in patient charges. **Conclusion:** Routine consultation of a poison control system by emergency medical dispatchers can reduce unnecessary dispatches, ambulance transports, and ED visits with significant associated cost savings. It is impossible to determine that some of these patients did not ultimately seek care on their own.

14. EFFECTS OF A MOBILE HEALTH PARAMEDIC PROGRAM ON THE REDUCTION OF 9-1-1 USE BY FREQUENT CALLERS

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Background: A common problem in the current health-care delivery model is frequent use of 9-1-1 by patients with non-emergent conditions. In an effort to decrease the frequency of 9-1-1 use by this subset of patients, a Mobile Health Paramedic (MHP) program was implemented. Our goal was to evaluate the effect of the MHP program on frequency of 9-1-1 use by this type of patient. **Methods:** The 9-1-1 database was searched to identify patients who called 9-1-1 a minimum of 15 times in 90 days. Those identified were offered the opportunity to volunteer for enrollment in the MHP program. Visits by an MHP were scheduled, and patient's health-care needs and reasons for frequency of 9-1-1 use were evaluated. Care plans were developed to help patients better manage their health-care needs and overcome difficulties in navigating the health-care system. Patients were also given a 10-digit phone number as an alternative to 9-1-1 in non-emergency situations. This was answered by emergency medical dispatchers, who followed protocols to identify the appropriate response to meet the patient's needs, which could include a MHP or traditional emergency response. Upon demonstration of the ability to adequately manage their individual health-care needs and appropriate utilization of 9-1-1, patients were graduated from the MHP program. A retrospective analysis of 9-1-1 calls from the MHP program patients between July 1, 2009 and June 30, 2013 was performed. Patients with 12 months of data prior to enrollment and 12 months after graduation were evaluated for any change in frequency of 9-1-1 use. **Results:** 45 of the 70 patients enrolled in the MHP program met the inclusion criteria. The average frequency of 9-1-1 use for the 12-month pre-enrollment period was 28.31. The average frequency of 9-1-1 use for the 12 months after graduation was 3.22, an 85.37% decrease ($p < 0.0001$). Fourteen patients had no 9-1-1 calls after graduation. The average length of enrollment in the MHP program was 6.98 months. **Conclusion:** A MHP program can significantly decrease 9-1-1 use by frequent callers.

15. PREHOSPITAL NITROGLYCERIN IN TACHYCARDIC CHEST PAIN PATIENTS: RISKY OR NOT?

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Background: Nitroglycerin (NTG) is administered frequently by prehospital care providers for chest pain. Due to concerns that NTG could provoke hypotension in patients with elevated heart rates, tachycardia (>100 bpm, in the absence of heart failure) was added as a contraindication to NTG in the 2010 American Heart Association guidelines (AHA). In response to a lack of scientific evidence to support the contraindication, we sought to determine whether NTG administration for chest pain is more likely to cause hypotension (systolic blood pressure < 90 mmHg) in patients with tachycardia compared to patients without tachycardia ($50 < HR \leq 100$). **Methods:** We performed a retrospective chart review of primary care paramedic (PCP) run sheets in a large urban Canadian EMS system during the three years preceding their 2013 implementation of the AHA guidelines. Data were reviewed by trained data technicians; entries that extended beyond normal range were reviewed by an investigator. We used logistic regression to calculate odds ratios (OR) and 95% confidence intervals (CI) for the association between NTG-induced hypotension and tachycardia independent of age, sex, and four comorbidities. Secondary outcomes included blood-pressure drop ($= 30$ mmHg), bradycardia (HR

< 50), cardiac arrest, and reduced level of consciousness. **Results:** The cohort included 10,413 consecutive prehospital patients administered NTG by PCP; 2079 (20%); patients were tachycardic before NTG administration. Hypotension occurred in 331 (3.2%) patients: in 249 (3%) without tachycardia and 82 (3.9%) with tachycardia. Tachycardic patients showed increased adjusted odds of hypotension when compared to non-tachycardic patients (OR 1.35; CI 1.04–1.74). Hypotension was not associated with age, sex, or comorbidities. In secondary analyses, odds increased for a drop in systolic pressure in the tachycardic group (OR 1.28; CI 1.16–1.42), while there were decreased odds of the same group experiencing bradycardia (OR 0.28; CI 0.14–0.58). **Conclusions:** The absolute risk of NTG-induced hypotension was low. There was a statistically significant increase in the relative risk of hypotension with NTG administration in patients who were tachycardic. EMS medical directors reviewing PCP chest pain protocols should weigh the potential benefits of NTG administration against its known risks.

16. COMPRESSIONS DURING DEFIBRILLATOR CHARGING SHORTENS SHOCK PAUSE DURATION AND IMPROVES CHEST COMPRESSION FRACTION DURING SHOCKABLE OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Previous studies have demonstrated significant relationships between shock pause duration and survival to hospital discharge from out-of-hospital (OHCA) shockable cardiac arrest. Compression during defibrillator charging (CDC) has been proposed as a technique to shorten shock pause duration. We sought to determine the impact of CDC on shock pause duration and CPR quality measures in shockable OHCA. **Methods:** We performed a retrospective review of all treated adult OHCA occurring over a 1-year period beginning August 1, 2011 after training EMS agencies in CDC. We included OHCA patients with an initial shockable rhythm, available CPR process, and shock pause data for the first three shocks of the resuscitation. CDC by EMS personnel was confirmed by review of impedance channel measures. We evaluated the impact of CDC on shock pause duration as the primary outcome measure. Secondary outcome measures were the impact of CDC on CPR quality measures. **Results:** Among 674 treated OHCA, 158 (23.4%) presented in a shockable rhythm, of which 129 (81.6%) met study inclusion criteria. Seventy (54.2%) received CDC. There was no significant difference between the CDC and no CDC group with respect to Utstein variables. Mean pre-shock pause (24.3 vs. 8.7 sec; $d = 15.6$; 95% CI: 12.7, 18.5), post-shock pause (6.0 vs. 3.8 sec; $d = 2.2$; 95% CI: 0.8, 3.5), and per-shock pause (30.3 vs. 12.3 sec; $d = 18.0$; 95% CI: 14.7, 21.3) were all significantly lower for those who received CDC. Mean chest compression fraction was significantly greater (0.77 vs. 0.70, $d = 0.07$; 95% CI: 0.03, 0.11) with CDC. No significant difference was noted in compression rate or depth with CDC. Clinical outcomes did not differ between the two approaches (return of spontaneous circulation 62% vs. 62% $p = 0.98$, survival 25.4% vs. 27.1% $p = 0.82$), although the study was not powered to detect clinical outcome differences. **Conclusions:** Compressions during defibrillator charging shortens shock pause duration and improves chest compression fraction in shockable OHCA. Given the impact on shock pause duration, further study with a larger sample

size is required to determine the impact of this technique on clinical outcomes from shockable OHCA.

17. PREHOSPITAL ASPIRIN ADMINISTRATION FOR ACUTE CORONARY SYNDROME (ACS) IN THE UNITED STATES: AN EMS QUALITY ASSESSMENT USING THE NEMESIS (NATIONAL EMS INFORMATION SYSTEM) DATABASE

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Background: National practice guidelines recommend early aspirin administration for acute coronary syndrome (ACS) to reduce mortality. While timely administration of aspirin has shown to reduce mortality in ACS by 23%, prior regional EMS data have shown inadequate aspirin use in patients with suspected cardiac ischemia. Using the National EMS Information System (NEMESIS) database, we sought to determine 1) the proportion of patients with suspected cardiac ischemia who received aspirin and 2) which patient characteristics independently predicted administration of aspirin. **Methods:** Analysis of the 2011 NEMESIS database targeted patients = 40 years old with a paramedic primary impression of 'chest pain.' To identify patients with chest pain of suspected cardiac etiology, we included those with EKG or cardiac monitor performed. Trauma related chest pain and basic life support transports were excluded. The primary outcome was defined as presence of aspirin administration. Patient characteristics of age, gender, ethnicity/race, insurance status, and United States region were also obtained. Multivariate logistic regression was used to assess the independent association of patient factors with aspirin administration for suspected cardiac ischemia. **Results:** Of the total 14,371,941 EMS incidents in the 2011 database, there were 198,231 patients who met our inclusion criteria (1.3%). Of those, 45.4% received aspirin from the EMS provider. When compared to Non Hispanic White patients, several groups had greater odds of aspirin administration by EMS. Non Hispanic Blacks (OR 1.49, 95% CI 1.44-1.55), Non Hispanic Asians (OR 1.62, 95% CI 1.21-2.18), Hispanics (OR 1.71, 95% CI 1.54-1.91), and other Non Hispanics (OR 1.27, 95% CI 1.07-1.51) all had greater odds of receiving aspirin. Patients living in the southern region of the United States (OR 0.85, 95% CI 0.81-0.89) and patients with governmental insurance (OR 0.67, 95% CI 0.57-0.78) had lower odds of receiving aspirin. Age and gender (OR 1.00, 95% CI 1.00-1.00) were not associated with aspirin administration. **Conclusions:** Our results confirmed that aspirin administration for suspected ACS could be improved. There were regional, ethnic/racial, and insurance-based disparities noted in aspirin administration. Further qualitative assessment of these practice variations will help identify and develop interventions to improve quality of prehospital ACS care.

18. CHARACTERISTICS OF PATIENTS WHO DO NOT UNDERGO PCI AFTER PREHOSPITAL CARDIAC CATHETERIZATION LAB ACTIVATION

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Background: Prehospital activation of cardiac catheterization labs (CCL) has been demonstrated to improve the morbidity and mortality of patients suffering from a ST elevation myocardial infarction (STEMI). Reducing the incidence of false activations could improve the

efficiency of these types of protocols. The objective of this analysis was to assess the clinical and ECG characteristics of patients classified as a STEMI in the prehospital setting to determine which characteristics were associated with not undergoing primary coronary intervention (PCI). **Methods:** We performed a retrospective analysis of prehospital CCL activations in a single urban EMS system between May 2008 and March 2011. Data were extracted from the prehospital patient record, prehospital ECG, and the regional STEMI database. Patients with a prehospital STEMI activation were classified as either not having a PCI or undergoing a PCI based on the presence of a lesion treatment time in the STEMI database. Independent variables included objective patient characteristics: age, sex, race, heart rate, systolic blood pressure, presence of a bundle branch block (BBB), left ventricular hypertrophy (LVH), QRS complex duration, and other comorbidities (e.g., diabetes or hypertension). Cases with incomplete records, missing prehospital reports, missing prehospital ECG, or cases with violations of the prehospital STEMI activation protocol were excluded from analysis. **Results:** There were 341 prehospital STEMI activations during the study period with 231 complete records. The variables associated with an increased likelihood of not having a lesion treatment time were any type of BBB (OR = 4.6; 95% CI: 1.91-11.27), LVH (OR = 5.8; 95% CI: 2.81-12.16), and race other than white (OR = 2.8; 95% CI: 1.64-4.90). Increased age and heart rate were also associated with not having lesion treatment. Of the comorbidities analyzed none were statistically significant. One clinical characteristic (presence of arm pain) was shown to decrease the odds of not undergoing PCI (OR = 0.36; 95% CI: 0.20-0.66). **Conclusions:** There were several variables associated with a decreased likelihood of undergoing PCI: BBB, LVH, and non-white race. Results from this analysis may prove useful when designing protocols for prehospital CCL activation of STEMI patients. Inclusion of clinical characteristics such as BBB or LVH in activation guidelines may reduce false activations.

19. PREHOSPITAL ADMINISTRATION OF OXYGEN FOR CHEST PAIN PATIENTS DECREASES SIGNIFICANTLY FOLLOWING IMPLEMENTATION OF THE 2010 AHA GUIDELINES

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Background: Since 2010, the American Heart Association (AHA) Emergency Cardiovascular Care guidelines no longer recommend routine administration of supplemental oxygen (O₂). This applies to hemodynamically stable patients experiencing chest pain whose oxygen saturation (SpO₂) is = 94%. This study examined trends in prehospital oxygen administration by emergency medical services (EMS) providers following publication of this guideline. **Methods:** This retrospective study analyzed data obtained from Fisdap™, a national clinical skills tracking system for EMS students. Clinical skills are self-reported and then verified by a student's preceptor. Inclusion criteria included 1) student consent for research, 2) patient presented with a chief complaint of cardiac chest pain, and 3) SpO₂ data recorded. Exclusion criteria included 1) SpO₂ < 94%, 2) cases with documented positive pressure ventilation, continuous positive airway pressure, or any other indication of criticality, and 3) patients who could be considered clinically hemodynamically unstable (systolic blood pressure < 100 or > 250; heart rate < 60 or > 100). The study time period included data from 6 months prior to publica-

tion of the 2010 AHA guidelines through December 31, 2012. Unadjusted logistic regression was used to determine if O₂ administration changed significantly over the 3 years studied (2010-2012). **Results:** A total of 10,558 patient encounters by 2,447 paramedic students from 195 US paramedic programs were included for analysis. In 2010, 71.9% (488/1738) of patients with SpO₂ = 94% received supplemental O₂. Compared to 2010, this rate decreased significantly in 2011 to 64% (1,820/5,050) and to 53.1% (1,767/3,770) in 2012 (p < 0.001, respectively). The odds of a hemodynamically stable chest pain patient with SpO₂ = 94% receiving supplemental oxygen in 2011 were 1.4 times lower compared to patients in 2010 (95% CI 1.3-1.6). Similarly, the odds of patients in 2012 receiving supplemental oxygen were 2.3 times lower compared to patients in 2010 (95% CI 2.0-2.6). **Conclusion:** This is the first examination of prehospital administration of supplemental O₂ following release of the 2010 updated guidelines. There has been a statistically significant decrease in supplemental O₂ administration; however, 50% of patients not meeting criteria for administration are still receiving supplemental O₂.

20. PREHOSPITAL CREATININE DECREASES

DOOR-TO-CT TIME BUT NOT

DOOR-TO-TREATMENT TIME IN STROKE PATIENTS UNDERGOING ACUTE INTERVENTIONAL THERAPY

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Background: Advanced stroke centers routinely include CT angiogram (CTA) in addition to the standard non-contrast head CT scan prior to making the decision of whether or not to treat a patient with tissue plasminogen activator (tPA) and/or endovascular therapy (EVT). In order to perform CTA, it is essential to obtain a serum creatinine level, as renal insufficiency is a contraindication to intravenous contrast. Life Force ambulance helicopters are equipped with point-of-care creatinine that allows patients to bypass the emergency department (ED) and be taken straight to CT scan. We hypothesize that in patients with acute ischemic stroke, a prehospital serum creatinine decreases door-to-CT scan (D2CT) and door-to-treatment (D2Tx) times. **Methods:** Retrospective analysis of consecutive stroke patients undergoing acute stroke interventional therapy with TPA and/or EVT who presented to Erlanger Medical Center from January 1, 2008 through December 31, 2012. The two-sample t-test was utilized to compare D2CT times, D2TPA times, and D2EVT times in patients with and without a prehospital creatinine. Regression analysis was performed to control for effects of age, sex, duration of stroke symptoms, baseline NIH score, and hour of presentation. **Results:** Of the 332 study patients, 88 patients had a prehospital creatinine and 244 patients did not. Mean NIH stroke scale was 16.2 ± 4.4 in patients with a prehospital creatinine and 15.8 ± 5.3 in patients without a prehospital creatinine. 111 (33.4%) patients received TPA therapy, 165 (49.7%) received EVT, and 56 (16.8%) had combined TPA + endovascular therapy. Overall in-hospital mortality was 22.7%. There were no differences in the demographic features between the two study groups. Patients with a prehospital creatinine had a 17.6-minute shorter D2CT time as compared to patients without a prehospital creatinine (95% CI 15.1 to 20.1 min; p < 0.0001). There were no differences in D2TPA and D2EVT times in patients with and without a prehospital creatinine. Regression analysis found no other factors associated with delays in D2CT time, D2TPA time, and D2EVT time. **Conclusions:** Use of prehospital

creatinine significantly shortens D2CT times, but not D2TPA or D2EVT. This disparity was likely from the delay waiting for the patient to return from CT scan before an ED physician evaluation.

21. ACUTE ISCHEMIC STROKE PATIENTS RECEIVE THROMBOLYTIC THERAPY AT HIGHER RATE WHEN TRANSPORTED BY EMS

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Background: AHA/ASA guidelines describe the timely diagnosis and treatment of the acute ischemic strokes with tissue plasminogen activator (t-PA) as hallmarks of emergent stroke care. Previous studies have shown that although just over half of all stroke patients use EMS to access the health-care system, those who arrive by ambulance comprise the majority of patients presenting within the 3-hour window. The purpose of this study was to compare the rates of administration of t-PA in patients diagnosed with acute ischemic stroke based on their method of transport to the hospital. **Methods:** A retrospective review was performed on data submitted to the Los Angeles County EMS Agency by local approved stroke centers from 2011 to 2012 on patients with a final diagnosis of acute ischemic stroke. Outcomes reported include mode of arrival (by ambulance or not specified) and administration of t-PA. **Results:** In 2011, 1,969 patients with a final diagnosis of ischemic stroke were transported by EMS, and of these 359 received t-PA (18.2%). In this same year, 3,874 patients diagnosed with ischemic stroke arrived to stroke centers by unspecified means, and of these only 274 (7.1%) received t-PA. Similarly in 2012, 2,008 patients with acute ischemic stroke were transported by EMS, of which 371 (18.5%) received t-PA, whereas 3,674 patients arrived by unspecified means, of which 272 (7.4%) received t-PA. **Conclusions:** Acute ischemic stroke patients known to be transported by EMS received t-PA at more than twice the rate of those arriving by unspecified means of transport (18% versus 7%). These rates were stable between 2011 and 2012. An unknown portion of patients arriving by unspecified means may have been transported by EMS.

22. ADENOSINE UTILIZATION AND EFFECT ON SUPRAVENTRICULAR TACHYCARDIA IN A LARGE, URBAN EMS SYSTEM

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Background: Emergency Medical Services (EMS) protocols commonly enable paramedics to administer adenosine for supraventricular tachycardia (SVT). There is a paucity of literature on adenosine utilization and effect on SVT in EMS patients. This study's purpose was to focus upon how paramedics utilize adenosine and the changes that occurred in presumed SVT treated with adenosine. The study EMS system is located in two large, urban municipalities in the southwestern United States. The study EMS system utilizes standing order protocols specifying adenosine 12 mg rapid intravenous push for adult stable SVT, defined by regularly occurring, narrow QRS complexes indicating ventricular response rates exceeding 150 beats per minute (bpm), with systolic blood pressure at least 100 mmHg. Repeating adenosine 12 mg is allowed if initial dosing ineffective in converting presumed SVT. **Methods:** Retrospective chart review of consecutive patient encounters involving administration of adenosine in adults (defined as 18 years of age or greater)

with presumed SVT occurring January 1, 2012 to January 1, 2013 in the study EMS system. **Results:** In the 12-month study period, 252 adult patient encounters involved adenosine administration for presumed SVT. 153/252 (60.7%) patients were female. Mean patient age was 54.8 years. Mean pre-adenosine heart rate was 187 bpm, with ECG review revealing 221/252 (87.7%) patients to be experiencing SVT. The next most common pre-adenosine ECG rhythm was atrial fibrillation with rapid ventricular response (RVR) in 17/252 (6.8%) patients. Protocol compliance with adenosine dosing was particularly high, 247/252 (98.0%) patients receiving initial adenosine dosing of 12 mg. A second adenosine dose was administered in 77/252 (30.6%) patients. Mean post-adenosine heart rate was 138 bpm, with ECG review revealing the following common post-adenosine rhythms: 100/252 (39.7%) sinus tachycardia; 58/252 (23.0%) sustained SVT; 49/252 (19.4%) sinus rhythm; 28/252 (11.1%) atrial fibrillation with RVR. 241/252 (95.6%) of study patients were transported by EMS to an emergency department. **Conclusions:** In a sizeable adult EMS patient cohort receiving adenosine for presumed SVT, nearly 60% of patients were converted to a sinus rhythm with heart rates less than 150 bpm. Paramedic protocol compliance for stable presumed SVT was very high.

23. FEASIBILITY OF REMOTE ISCHEMIC CONDITIONING IN THE PREHOSPITAL AIR TRANSPORT ENVIRONMENT: A CASE SERIES

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Background: Rapid reperfusion through primary percutaneous coronary intervention (PCI) is the preferred method to reduce infarct size and mortality. Remote ischemic conditioning (RIC) is a promising adjuvant therapy that may reduce infarct size, but use remains low. We aimed to evaluate the feasibility of providing RIC in patients with STEMI undergoing air medical transport for primary PCI. **Methods:** We report process and procedural outcomes of a case series of STEMI patients as part of a 4-month pilot protocol to provide RIC during air medical transport for primary PCI. Between March and July 2013, eligible patients received four cycles of forearm ischemia induced by inflating a blood pressure cuff to 200 mmHg for 5 minutes followed by 5 minutes with the cuff deflated. Data regarding feasibility, process variables, and patient comfort were obtained from prehospital patient care reports and prospectively completed QI surveys by crew members. The primary outcome was whether at least 3 cycles of RIC were completed. Secondary outcomes included patient discomfort level and number of cycles of RIC completed prior to PCI. Analysis was performed using descriptive statistics. **Results:** Twenty-four patients (21 interfacility and 3 scene transports) qualified for RIC. The mean age was 62 ± 15 and 67% were men. Median bedside/scene time was 8 minutes (IQR 7, 10) and median flight time was 24 minutes (IQR 20, 29). Twenty patients (83%) completed at least three cycles of RIC and 16 patients (68%) completed all four cycles. Patients reported a median patient discomfort of 0.5 out of 10, with 11 patients reporting no discomfort and only one patient reporting discomfort greater than 5 (discomfort = 10). One patient was excluded prior to RIC due to cardiac arrest and three had early termination during the first cycle due to reported pain, hypotension, or change in destination. **Conclusions:** RIC appears to be both feasible and safe to implement for STEMI patients undergoing air medical transport for primary PCI. The incidence

of excessive procedural discomfort or hemodynamic instability is rare. STEMI patients requiring transfer may be the ideal group for RIC utilization during interhospital transfer.

24. NATIONAL TRENDS IN EMS UTILIZATION FOR TIME-SENSITIVE CONDITIONS OF AMI AND STROKE

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Background: Acute myocardial infarction (AMI) and stroke are time-sensitive conditions with significant morbidity and mortality. While regional studies have shown underutilization of EMS for both of these conditions, national comparison and time trends have not been analyzed. The primary objective of this study was to describe the prevalence of EMS use by AMI and stroke patients in the US, establish EMS utilization trends over a 6-year period, and examine patient factors that may influence its use. **Methods:** We analyzed data collected by the National Hospital Ambulatory Medical Care Survey-ED (NHAMCS), which is a nationally representative, multicenter, stratified sample of ED visits between 2003 and 2009. We included patients with a primary diagnosis of ischemic stroke and AMI, defined by ICD9 codes. The primary outcome was ED arrival by ambulance. We used survey visit weights provided by the NHAMCS to estimate the national proportion of patients diagnosed with stroke and AMI in EMS transported patients. Logistic regression modeling was used to determine factors independently associated with EMS use. **Results:** From 2003 to 2009, 1,324 stroke patients were analyzed, and 666 (50.3%) presented to the ED by EMS. During the same period there were 442 AMI patients and 220 (49.8%) presented by EMS. For both of these conditions there was no significant change in EMS usage during the study period. Older age, nursing home residence, insurance status, and geographic regions were all correlated with arrival by EMS for stroke patients. For AMI patients, variables associated with EMS arrival were race/ethnicity, nursing home residence, and insurance. The factors independently associated with EMS use were age (OR 1.21; 95% CI 1.12-1.31), Non-Hispanic black race (OR 1.72; 95% CI 1.16-2.29) and nursing home residence (OR 11.50; 95% CI 6.19-21.36). **Conclusions:** Using data from a nationally representative sample of ED visits, we found that, despite national efforts to improve EMS use for time-sensitive conditions, trends have remained stable. Rather than communitywide efforts, future efforts should target high-risk areas with lower EMS utilization rates.

25. PREHOSPITAL DIFFERENCES BETWEEN PATIENTS WITH ISCHEMIC AND HEMORRHAGIC STROKES

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Background: Paramedics frequently evaluate and treat patients with suspected cerebrovascular accidents (CVAs). It is difficult to tell which of these patients have hemorrhagic strokes and which have ischemic strokes. Being able to differentiate between these diagnoses would help paramedics and physicians determine the best initial management of these patients. We sought to determine if there were differences noted in the prehospital setting between patients with hemorrhagic and ischemic strokes. Design: Retrospective cohort. Setting: A large, suburban, hospital-based EMS system. Protocol: The prehospital and emergency department records of all patients for which paramedics were dispatched for "Stroke" over

a 3-year period were reviewed. Based on the emergency department records, patient were categorized as having either ischemic CVA, hemorrhagic CVA, or "other." Only patients with ischemic or hemorrhagic CVAs were included in the study. Using the prehospital records, demographics, blood pressures, heart rates, and rates of intubation were measured for the two groups. Difference between groups and 95% confidence intervals (CI) were calculated. **Results:** Of 10,847 ALS dispatches, 449 (4.1%) were dispatched as "Stroke." Of these, 250 (56%) were diagnosed with a CVA in the ED. Of the 250 CVAs, 223 (89%) were ischemic and 27 (11%) were hemorrhagic. There were no age or gender differences between the two groups, and the average heart rates between the two groups were similar. The average blood pressure in the ischemic CVA group was 149/81 versus 166/93 in the hemorrhagic group (systolic difference = 17; CI: 5, 29; diastolic difference = 12; CI: 5, 19). The rate of intubation in the ischemic CVA group was 2% compared to 11% in the hemorrhagic CVA group (difference = 9%, CI: 3, 16). **Conclusions:** Compared to patients with ischemic CVAs, patients with hemorrhagic CVAs tend to have higher systolic and diastolic blood pressures and higher rates of intubation in the prehospital setting. These characteristics may help guide providers in the management of patients before a definitive diagnosis is made.

26. A PREHOSPITAL TREAT-AND-RELEASE PROTOCOL FOR SUPRAVENTRICULAR TACHYCARDIA

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Background: Paroxysmal supraventricular tachycardia (SVT) is a common cardiac dysrhythmia treated in the prehospital setting. Emergency medical service (EMS) agencies typically require patients treated for SVT out-of-hospital to be transported to hospital for evaluation by a physician. This study evaluated the safety and effectiveness of a treat-and-release (T+R) protocol enabling advanced care paramedics (ACPs) to treat uncomplicated SVT in the field, without transport to an emergency department (ED). **Methods:** This study linked data from the Alberta Health Services (AHS) EMS Electronic Patient Care Record (EPCR) database for the City of Calgary, to the AHS Calgary Zone Regional Emergency Department Information System (REDIS) database. All SVT patients treated by EMS between September 1, 2010 and September 30, 2012 were identified and linked to the REDIS database. Databases were queried to identify any T+R patient re-presenting to EMS or an ED within 72 hours of initial treatment. **Results:** There were 75 SVT T+R patient encounters. With incomplete records excluded, 54 of 60 T+R encounters (90%, 95% CI [80, 95]) met all protocol criteria for T+R. 10 T+R encounters led to an EMS re-presentation within 72 hours. Four T+R encounters led to an ED presentation within 72 hours. Two of the ED presentations led to treatment and discharge for SVT, while two resulted in admission for conditions unrelated to SVT. All 14 re-presentations could be attributed to a single individual. **Conclusion:** These findings suggest EMS practitioners are able to follow a T+R protocol for SVT with reasonable adherence to protocol requirements. The T+R protocol evaluated in this study appears to be effective and safe in selecting appropriate patients, and suggests that T+R is a viable option for patients presenting with uncomplicated SVT in the prehospital setting.

27. PRESENT URBAN-RURAL GAP IN PREHOSPITAL DELAY OF ACUTE STROKE PATIENTS IN KOREA

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Background: Although it is important to transport ischemic stroke patients to a stroke center in proper time, there is a gap between urban and rural in time interval from stroke onset to hospital arrival. The aim of this study was to investigate the factors affecting these differences and present the basic information for establishing the efficient regional hub and spoke system for stroke patients. **Methods:** This retrospective study was based on adult patients diagnosed as acute ischemic stroke from January 2012 to December 2012 at a regional cerebrovascular center. 'Acute' was defined as 24 hours from symptom recognized; 'urban' was defined as within the boundary of a metropolitan area. The distance from symptom onset location to stroke center was calculated by using the global positioning system. **Results:** In this study, 722 patients were analyzed (urban: 436, rural: 286). In the case of the patients who developed acute ischemic stroke in an urban area, the proportion arriving at a stroke center within 3 hours was 27.5%; on the other hand, that of the patients who developed acute ischemic stroke in a rural region was 19.2%, which has been shown to be a statistically significant difference ($p < 0.011$). Through multivariate logistic regression analysis, the use of public ambulance (OR: 4.258, CI: 2.233-8.118) and transportation from other hospitals (OR: 0.416, CI: 0.216-0.800) have been shown to have a statistically significant difference in urban patients. But in rural cases, only the distance from symptom onset location to stroke center was revealed to be an affecting factor of delay (OR: 0.982, CI: 0.969-0.995). We have calculated the distance from symptom onset location to stroke center with assumption which has been arrived at emergency department within 3 hours from symptom recognition, as 45 kilometers. **Conclusion:** To increase the use of tissue plasminogen activator in urban settings, it should be emphasized that acute stroke patients must use public ambulances and be transferred directly to a stroke center. We also concluded that the new hub hospital and the policy about it are necessary for the intravenous tissue plasminogen activator before transporting patients to stroke center to minimize the gap between urban and rural.

28. AN ASSESSMENT OF POTENTIAL TIME SAVINGS AND SAFETY OF BASIC LIFE SUPPORT EMS STEMI BYPASS

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Background: The American Heart Association suggests emergency medical service (EMS) providers transporting ST-segment elevation myocardial infarction (STEMI) patients to a percutaneous coronary intervention (PCI) center require advanced life support (ALS) skills. The objective was to evaluate the potential time savings and safety of basic life support defibrillation-trained (BLS-D) EMS transport to a PCI center in a system where only ALS-EMS providers are authorized to bypass non-PCI hospitals. **Methods:** We reviewed 77 consecutive patients meeting ECG STEMI criteria transported by BLS-D as per protocol by one of three paths: (A) to the closest emergency department (ED) with secondary transfer by ALS to a PCI center, (B) en route rendezvous with ALS and diversion to a PCI center, and (C) to the PCI center ED if it was

closest. Transport times to the PCI center were compared with corresponding predicted transport times determined by mapping software (MapPoint, Microsoft) had BLS-D followed a direct path. Lastly, we recorded predetermined clinically important events. **Results:** 15, 51, and 11 patients followed paths A, B, and C, respectively. Median transport times for path A were 7 (IQR 5) minutes to reach the ED of the nearest non-PCI center and 71 (IQR 57) minutes to the PCI center compared with a median predicted 12 (IQR 7) minutes to a PCI center had these patients bypassed the nearest hospital (Wilcoxon signed rank tests, $P = 0.003$ and 0.001 , respectively). Median transport time for path B was 12 (IQR 8) minutes compared with a median predicted time of 11 (IQR 6) minutes had no ALS rendezvous occurred (Wilcoxon signed rank test, $P = 0.095$). Two patients experienced prehospital cardiac arrest (resuscitated with defibrillation); one required dopamine and two others received a saline bolus for hypotension. **Conclusions:** Substantial time savings could occur if BLS-D providers bypass the ED of a non-PCI center with only a small predicted increase (about 5 minutes) in the transport time to the PCI center. ALS rendezvous does not appear to substantially increase transport time. Given the low occurrence of clinically important events, our findings suggest that BLS-D bypass to a PCI center can be safe.

29. PREHOSPITAL STROKE ASSESSMENT AND TRIAGE USING NIHSS

Matthew Kesinger, Samantha Buffalini, Christian Martin-Gill, Francis Guyette, University of Pittsburgh

Background: Stroke treatment requires an integrated system of care that is capable of rapid recognition and specialized treatment. Helicopter emergency medical services (HEMS) play a key role in this system, rapidly transporting patients with stroke-like symptoms to regional centers capable of intervention. The National Institutes of Health Stroke Scale (NIHSS) is a tool that is used to predict the effectiveness of IV tPA. We investigated the agreement of prehospital providers with admitting neurologists when identifying patients with a stroke using the NIHSS and the ability of the NIHSS to predict large vessel occlusion. **Methods:** We reviewed data from 116 consecutive stroke patients who were evaluated by flight crews trained to use the NIHSS. The NIHSS score assigned by the HEMS providers during transport was compared to the score given by the admitting neurologist in the emergency department of a comprehensive stroke center. For comparison the NIHSS was divided into bins representing clinically actionable values (0-3 no intervention, 4-11 mild-moderate stroke, 12 moderate-severe stroke). We also described the ability of the HEMS provider to predict large vessel occlusion using the NIHSS (NIHSS > 11 is associated with large vessel occlusion). Prediction performance was compared to neurologists using receiver operating characteristics (ROC) curves. **Results:** There was moderate agreement ($\kappa = 0.58$ 95% CI 0.49-0.67) between flight crew and neurologists when assessing stroke patients using the NIHSS. Flight crews were able to predict large vessel involvement with a ROC area under the curve (AUC) 0.75 (95% CI 0.63-0.87). No difference was observed in the ability of the neurologist to identify large vessel involvement compared to the flight crew AUC 0.77 (95% CI 0.67-0.86). **Conclusions:** There is moderate agreement between NIHSS performed by flight crews and neurologists. A NIHSS performed in the field by trained providers can identify large vessel involvement. The prehospital use of the NIHSS

may inform triage decisions and increase the likelihood of stroke intervention.

30. DIFFERENTIATION OF STEMI FROM STEMI MIMICS USING AN ECG ALGORITHM

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Background: Accurate ECG diagnosis of ST-elevation myocardial infarction (STEMI) by prehospital providers is critical for provision of out-of-hospital care. The purposes of this study included: to evaluate the accuracy of ECG STEMI interpretation in a 'control' ALS population; to test the impact of a 4-step ECG interpretation algorithm on STEMI diagnostic performance in an intervention group; and to determine whether the algorithm improves the distinguishing of STEMI from common mimics. **Methods:** Two online surveys were used for the study: one that asked participants to use a 4-step algorithm to diagnose STEMI and another that did not. Percentages of accurate STEMI and not STEMI diagnoses, odds ratios, 95% confidence intervals, and Pearson chi-square testing were calculated. Participants were compared based on their level of training and experience. **Results:** A total of 48 and 49 ALS providers participated in the Algorithm and Control surveys, respectively. STEMI was correctly diagnosed 91.1% (Algorithm) compared with 90.8% (Control; $p = 0.92$). Providers were correct in not diagnosing STEMI 70.3% (Algorithm) compared with 68.9% (Control; $p = 0.66$). The anterior wall STEMI was diagnosed least correctly of STEMI pattern in both the Algorithm and Control groups (77.0% and 75.5%, respectively; $p = 0.86$) when compared to inferior wall STEMI (95.8 and 95.9%; $p = 1$). Within the EMT-P providers subgroup, there was a statistically significant difference ($p = 0.037$) in recognition of LBBB as not STEMI (OR 2.96; 95% CI 1.05-8.36) comparing the Algorithm to Control groups. While not statistically significant ($p = 0.068$), the Algorithm group appeared more likely to recognize a paced rhythm as not STEMI (OR 3.59; 0.858-15.1). **Conclusion:** The results of this pilot study suggest that EMS providers demonstrate high degree of accuracy for classical STEMI ECG diagnosis, yet have varied performance recognizing certain types of STEMI and when differentiating STEMI from common STEMI mimickers. Presentation of a structured step-wise diagnostic approach appears to improve diagnosis of STEMI from certain STEMI mimics, especially among EMT-P. These preliminary results suggest that education aimed at better differentiation between STEMI and STEMI mimickers is needed.

31. A MULTICENTER RANDOMIZED TRIAL COMPARING A MECHANICAL CPR ALGORITHM USING LUCAS VS MANUAL CPR IN OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS (LINC STUDY): ANALYSIS OF A PREDEFINED POPULATION

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Background: Manual chest compressions are often not optimal. Due to fatigue and other factors, compression rate and depth are often incorrect and compressions are paused for defibrillation. These might be major factors contributing to poor outcome after out-of-hospital cardiac arrest (OHCA). We hypothesized that a new approach (L-CPR) with mechanical chest compressions delivered by the LUCAS device and defibrillation during ongoing chest compressions would improve 4-hour survival in patients as compared to guideline-based man-

ual cardiopulmonary resuscitation (M-CPR) in OHCA. **Methods:** In 6 European sites, from January 2008 to August 2012, 2,589 patients with OHCA were randomized to either L-CPR or M-CPR. A population, predefined in the protocol, of patients correctly included in the trial, treated according to protocol, with witnessed cardiac arrest, a dispatch time = 12 min and LUCAS initially brought to the patient was analyzed. Surviving patients were evaluated for neurological outcome using the Cerebral Performance Category (CPC) score with CPC 1-2 classified as good outcome. **Results:** The predefined population included 567 patients in the L-CPR and 566 in the M-CPR group. There was no difference in background variables between the groups. Surviving at 4 hours were 176 patients (31.0%) with L-CPR and 192 (33.9%) with M-CPR (risk difference 2.9%, 95% C.I. -2.57 - 8.33, $p = 0.31$). Survival with good neurological outcome was 71 (12.5%) vs. 69 (12.2%) ($p = 0.93$) at hospital discharge, 71 (12.6%) vs. 64 (11.4%) ($p = 0.58$) at one month and 72 (12.7%) vs 63 (11.3%) ($p = 0.46$) at 6 months after arrest in the L-CPR and M-CPR groups, respectively. The proportion of survivors with CPC1-2 in the L-CPR and M-CPR groups was 95% vs. 86% at hospital discharge, 99% vs. 88% at 1 month and 100% vs. 93% at 6 months after arrest. **Conclusions:** There was no significant difference in short- or long-term survival up to 6 months between patients treated with the LUCAS concept as compared to manual CPR in the predefined population. There was good neurological outcome in the vast majority of survivors in both groups.

32. BASIC LIFE SUPPORT PERSONNEL ARE HIGHLY SUCCESSFUL IN ESTABLISHING INTRAOSSEOUS ACCESS IN OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Intraosseous (IO) access has become the method of choice for the facile rapid delivery of fluids and medication in adult cardiac arrest patients. EMS systems limited in paramedic/ALS resources or all BLS first responders may provide clinical enhancements by allowing BLS providers to initiate IO prior to ALS arrival, thereby providing the potential for earlier BLS initiation of intra-arrest therapeutic hypothermia and initial pharmacology. The goal of this study was to determine the success of EMT-basic providers in establishing IO access in an adult cardiac arrest setting. **Methods:** This was a retrospective analysis of prospectively collected data abstracted from the cardiac arrest database maintained by the office of the medical director from a large urban EMS system. EMS standing orders were amended to allow credentialed EMT-basics to establish IO (EZIO[®], Vidacare, Shavano Park, TX) access (proximal humerus and proximal tibia) in cardiac arrests. EMT-basics performed the placement and stabilization of the IO device, and administered a 10-mL saline flush. The credentialing process included 2 hours of didactic, 2 hours of hands-on psychomotor training, and a field proctorship (direct observation for three placements). Successful placement was evaluated by the responding paramedics and defined as stable catheter placement with acceptable flow rates, without signs of extravasation. All cardiac arrests from 1/1/2012 to 6/30/2013 were included in the analysis. **Results:** There were a total of 1,581 cardiac arrest resuscitations attempted during the observation period. Average age was 62 ± 21 years and 60.4% male. IO access was successfully established in 1,402 (89%) of patients. IO was established by paramedics in 1,101 of the cases and by EMT-Intermediate in 2 patients. EMT-basics estab-

lished IO in 299 cases, with 270 patients receiving humeral IO and 27 receiving tibial IO. First attempt success for EMT-basics was 93% in the humerus and 89% in the tibia. Success after the second attempt, if necessary, was 99% in the humerus and 100% in the tibia. There were 7 (2.3%) complications that occurred after paramedic verification of secure placement. **Conclusion:** EMT-Basics demonstrated a high degree of success (93% 1st attempt) in establishing intraosseous access. A short training period is required with few complications reported.

33. EVALUATION OF THE RELATIONSHIP OF FUNCTIONAL SURVIVAL WITH THE THREE-PHASE MODEL OF OUT-OF-HOSPITAL CARDIAC ARREST IN THE ERA OF TARGETED TEMPERATURE MANAGEMENT

Ian Drennan, Kevin Thorpe, Laurie Morrison, University of Toronto

Background: Patient survival from out-of-hospital cardiac arrest (OHCA) decreases from the time of collapse to initial shock. This decrease in survival has been shown to occur in relation to the 3-phase model of cardiac arrest physiology: electrical, circulatory, and metabolic. There is limited research evaluating the relationship of the 3-phase model to functional survival at hospital discharge. Furthermore, the effect of targeted temperature management (TTM) on functional survival during each phase is unknown. This study aims to determine the effect of TTM on the relationship between the time of first shock and functional survival at hospital discharge. Furthermore, it will examine the effect of TTM on functional survival during each of the three phases of cardiac arrest physiology. **Methods:** This was a retrospective observational study of consecutive OHCA patients with initial shockable rhythm, treated by EMS personnel. Included patients obtained a return of spontaneous circulation (ROSC) in-hospital and were eligible for TTM. Multivariable logistic regression was used to determine the effect of time of initial shock on functional survival (modified Rankin scale) at discharge between patients who underwent TTM and those who did not. **Results:** There were 19,065 adult OHCA of presumed cardiac etiology treated by EMS, 871 were eligible for TTM. Of these patients 622 (71.4%) survived to hospital discharge, 487 (55.9%) with good neurological outcome. Poor functional survival at hospital discharge was associated with older age (OR 0.32; 95% CI 0.24-0.42) and longer time from collapse to initial shock (OR 0.32; 95% CI 0.22-0.46), while TTM was associated with improved functional survival (OR 1.63; 95% CI 1.07-2.46). Functional survival decreased during each phase of the model (73.1% vs. 68.4% vs. 52.7%, $p < 0.001$). There was a significant interaction between TTM and the time to initial shock on functional survival ($p < 0.01$). **Conclusion:** Functional survival at hospital discharge was associated with the length of time to initial shock, and decreased during each phase of the 3-phase model of cardiac arrest physiology. Post-arrest TTM was associated with improved functional survival and the effect of TTM was dependent upon the time of initial shock.

34. A COMPARISON OF DEFIBRILLATION EFFECTIVENESS AT 150J AND 200J IN PREHOSPITAL CARDIAC ARREST PATIENTS

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Background: The recommended first shock energy setting for biphasic Philips defibrillators (150J) is based on one study, which showed 96% first shock success for converting patients out of ventricular fibrillation (VF), but 2010 AHA guidelines suggest higher energy may be

necessary. Previously, local data showed a 52% first shock success rate for termination of VF, and paramedic protocols were changed to shock at 200J. We hypothesized that shock success would be higher at 200J than 150J. **Methods:** We reviewed cardiac arrest records (November 2009-August 2013) when first analysis resulted in shock delivery at 150J or 200J. Rescuers used Philips defibrillators and we analyzed up to four shocks. Shock outcomes were determined immediately and 5 minutes post-shock. The primary outcome was shock success defined as the immediate conversion of VF into a non-shockable rhythm. Outcomes were compared using chi-square. Associations between shock energy and outcome were examined using logistic regression. **Results:** We identified 297 shocks (126 subjects), including 235 (79%) 150J shocks and 62 (20%) 200J shocks. Successful termination of VF occurred in 140 (59.6%; 95%CI 53%-66%) 150J shocks and 41 (66.1%; 95%CI 54%-78%) 200J shocks ($p = 0.35$). Among first shocks ($n = 126$), termination of VF occurred at 150J in 67/107 (62.6%) and at 200J in 16/19 (84.2%) cases ($p = 0.067$). After 5 minutes 49 (21%) 150J shocks remained in VF, and 103 (44%) received another shock. After 5 minutes 11 (18%) 200J shocks remained in VF, and 30 (48%) received another shock. Shock energy and immediate post-shock success had no association (OR 1.35; 95%CI 0.75-2.44) adjusting for female sex (OR 1.74; 95%CI 1.00-3.01). After 5 minutes, shock energy was not associated with success (OR 1.11; 95%CI 0.75-2.44) adjusting for female sex (OR 2.23; 95%CI 1.30-3.83) and shock number (OR 2.52; 95%CI 1.52-4.16). Considering success defined as return of electrical activity, shock energy was not associated with shock success (OR 1.45; 95%CI 0.77-2.75) adjusting for response interval (OR 0.78; 95%CI 0.69-0.88), transthoracic impedance (OR 0.99; 95%CI 0.98-0.99) and female sex (OR 2.10; 95%CI 1.16-3.8). **Conclusions:** There was no association of shock energy and shock success. Female sex, lower transthoracic impedance, shorter response intervals, and first shocks were associated with better outcomes.

35. EVALUATION OF THE HEMODYNAMIC SYNERGY BETWEEN AN IMPEDENCE THRESHOLD DEVICE AND THE LUCAS 2 AUTOMATED CPR DEVICE IN A PIG MODEL OF CARDIAC ARREST

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Background: The combination of the LUCAS 2 (L-CPR) automated CPR device and an impedance threshold device (ITD) has been shown to enhance outcomes in patients after out-of-hospital cardiac arrest. The potential physiological synergy of these technologies has not been examined in animals. This study tested the hypothesis that L-CPR + an active ITD work synergistically to enhance cerebral and coronary perfusion pressures compared with L-CPR + a sham ITD. **Methods:** Ten female pigs (40.0 ± 4.0 kg) were sedated, intubated, anesthetized with isoflurane, and paralyzed with succinylcholine ($93.3 \mu\text{g}/\text{kg}/\text{min}$) to inhibit the potential confounding effect of gasping. After 4 minutes of ventricular fibrillation, 4 minutes of L-CPR (Physio-Control, Redmond, WA) + an active ITD (ResQPOD[®] 16, Advanced Circulatory, Roseville, MN) or L-CPR + a sham ITD was initiated and followed by another 4 minutes of the alternative method of CPR. The order of CPR interventions was randomized. Systolic (SBP), diastolic (DBP), diastolic right atrial pressure (RAP), intracranial pressure (ICP), airway pressure, and end tidal CO_2 (ETCO₂) were recorded con-

tinuously. Coronary perfusion pressure (CPP) was calculated as the difference between DBP and RAP during decompression. Cerebral perfusion pressure (CePP) was calculated as the difference between MAP and ICP. Hemodynamic data were averaged and compared over the last 2 minutes of treatment. A paired t test was used for statistical comparisons between groups. Data are expressed as mean mmHg \pm SD. **Results:** Mean airway pressure (a surrogate for intrathoracic pressure) was significantly lower with L-CPR + active ITD versus L-CPR + sham ITD (-5.13 ± 1.97 vs -0.49 ± 0.58 ; $p < 0.001$). L-CPR + active ITD treatment resulted in significantly improved hemodynamics versus L-CPR + sham ITD: ETCO₂, 34.9 ± 5.6 vs 28.9 ± 7.2 ($p = 0.015$); SBP, 98.7 ± 9.4 vs 92.5 ± 14.5 ($p = 0.050$); DBP, 24.4 ± 12.0 vs 19.4 ± 15.1 ($p = 0.006$); CPP, 29.4 ± 8.0 vs 26.3 ± 6.8 ($p = 0.004$) and CePP, 23.9 ± 12.6 vs 20.7 ± 11.8 ($p = 0.028$). **Conclusions:** In pigs undergoing L-CPR the addition of the ITD 16 significantly reduced intrathoracic pressure and increased systemic circulation. These data provide strong physiological support for this device combination.

36. THE EFFECT OF EMS PREHOSPITAL CATHETERIZATION LAB ACTIVATION ON MORTALITY, LENGTH OF STAY, DOOR TO BALLOON TIME, AND COST FOR ST-ELEVATION MYOCARDIAL INFARCTION (STEMI) PATIENTS

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Background: Previous literature has demonstrated that both EMS transport and EMS EKGs decrease time to reperfusion in STEMI patients. Little work has been done to evaluate the independent impact of prehospital activation (pre-activation) of the cardiac catheterization lab (CCL) to decrease time to reperfusion, and no literature exists documenting its impact on outcome. Our primary objective is to analyze the effects of acute myocardial infarction (AMI) team pre-activation for EMS STEMI patients on 1) mortality and 2) length of stay (LOS), door to balloon time (D2B), and cost of treatment. **Methods:** This retrospective cohort study took place at our two large, suburban, community emergency departments (ED), where AMI teams are activated for STEMI patients. Our population included all EMS-transported STEMI patients to our system from May 2006 to January 2012. The AMI teams are activated at the discretion of the emergency physician either before patient arrival via communication with EMS (pre-activation) or after patient arrival via ED assessment (ED activation). We recorded patient demographics, past history of coronary artery disease (CAD), process measures, and complications of STEMI. Our primary outcome is 30-day mortality, with secondary outcomes being LOS, D2B, and total hospital costs. Parametric and non-parametric tests were used for analysis. **Results:** During this study there were 531 EMS-transported STEMI patients. Of these, 232 (43.6%) had pre-activation. Pre-activation and ED activation groups were similar for age, gender, and prior CAD. Pre-activation was associated with a reduction in D2B (mean 53.3 min vs. 77.9 min, $p < 0.001$) and virtually all were reperfused within 90 minutes (97.0% vs 77.9%, $p < 0.001$). Pre-activation patients were less likely to sustain a cardiac arrest (14.7% vs. 24.7%, $p = 0.008$) and trended toward a decreased rate of cardiogenic shock (30.2% vs. 41.1%, $p = 0.07$). Despite earlier reperfusion, there was no significant decrease in mortality (7.6% vs. 8.7%, $p = 0.75$), LOS (5.0 days vs. 5.9 days, 95% CI Diff (-2.0, 0.35)), or hospital costs (\$20,880 vs. \$24,618, 95% CI Diff (-\$8,899, \$1,222)). **Conclusion:** In this single system study, despite improved time

to reperfusion with EMS pre-activation, it did not significantly improve mortality, decrease LOS, or reduce costs for STEMI patients.

37. IMPACT OF PREHOSPITAL INTRA-ARREST THERAPEUTIC HYPOTHERMIA ON ATTAINING RETURN OF SPONTANEOUS CIRCULATION

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Background: Post Return of Spontaneous Circulation (ROSC) therapeutic hypothermia has been shown previously to increase neurologic outcome after cardiac arrest. Multiple animal research models have also shown increased ROSC, left ventricular ejection fraction, coronary perfusion pressure, and neurologic function as well as a decrease in myocardial zone of infarct. Human research is more limited but the experimental models have suggested that intra-arrest therapeutic hypothermia (IATH) improves ROSC, survival to discharge, and neurologic function when compared to normothermic or post ROSC therapeutic hypothermia. The goal was to assess the impact of prehospital IATH on any period of ROSC and ROSC at hospital arrival. This study does not address impact upon survival or neurologic function at discharge but improving ROSC rates hopefully can contribute to improving downstream benefits. **Methods:** This was a retrospective analysis of prospectively collected data abstracted from the cardiac arrest database maintained by the office of the medical director of a large urban EMS system. EMS standing orders were amended to use IATH for non-traumatic adult cardiac arrest. Protocols direct application of ice packs externally and infusion of 4°C fluids at 100 mL/min up to 30 mL/kg to attain a target temperature of 32°C. All adult non-traumatic cardiac arrests from 1/1/2012 to 12/31/2012 were included in the analysis. Two main groups were established: IATH and no IATH but standard resuscitation (SR) and we looked at the presence of any ROSC and ROSC at hospital arrival. **Results:** There were a total of 983 adult cardiac arrest resuscitations of which 442 received SR and 541 received IATH. Prehospital ROSC was observed in 279 of 541 (51.57%) in the IATH group and 170 of 442 (38.46%) in the SR group with a p value < 0.0001 . ROSC at hospital arrival was present in 222 of 541 (41.04%) in the IATH group and in 133 of 442 (30.09%) of the SR group with a p value of 0.0004. **Conclusion:** Our observational data indicates intra-arrest therapeutic hypothermia increases pre-hospital ROSC.

38. VARIATIONS IN OUT-OF-HOSPITAL CARDIAC ARRESTS ACROSS 7 COUNTRIES IN ASIA: THE PAN ASIAN RESUSCITATION OUTCOMES STUDY (PAROS)

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Background: In 2010, Pan Asian Resuscitation Outcomes Study (PAROS) Clinical Research Network (CRN) was established in collaboration with Japan, Singapore, South Korea, Malaysia, Taiwan, Thailand, and UAE-Dubai. This CRN aims to report the out-of-hospital cardiac arrests (OHCA) events and provide a better understanding of OHCA trends in Asia. **Methods:** This is a prospective, international, multicenter cohort study of OHCA across the Asia-Pacific region. Each participating country provided between 1.5 and 2.5 years of data from January 2009 to December 2012. A

standardized taxonomy and case record form were adopted across the participating countries to collect common variables. Data were provided via two methods: using an electronic data capture (EDC) system, which is an on-line data registry, or exported data from a national registry. Cases included were presumed to have cardiac etiology and had resuscitation attempted by emergency medical services (EMS). Primary outcome was survival to hospital discharge or survived to 30 days post cardiac arrest. **Results:** A total of 64,692 cases from January 2009 to December 2012 were submitted to the PAROS CRN, of which 37,137 cases were presumed cardiac etiology and resuscitated by EMS. The mean age was 72.8 years (standard deviation [SD]: 16.4) and mainly were male (60.1%). 35.7% of cardiac arrests were witnessed by bystanders and 40.8% received bystander cardiopulmonary resuscitation; however, only 1.0% of these arrests received bystander defibrillation. For arrests that were witnessed to collapse and found in a shockable rhythm, the survival rate to hospital admission was 4.5%. Overall survival to hospital discharge for this group of patients was 2.4%. **Conclusion:** Survival to hospital discharge for Asia remains relatively low compared to North America and some European countries. This large population-based registry will provide a baseline to measure the effect of subsequent interventions such as dispatcher-assisted CPR and Public Access Defibrillation in this region.

39. EFFECT OF AIRWAY DEVICE CHOICE ON CHEST COMPRESSION FRACTION AND CPR RATIO

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Background: Current American Heart Association CPR guidelines emphasize maintenance of a high chest compression fraction (CCF) to increase the likelihood of return of spontaneous circulation. CPR ratio represents the proportion of uninterrupted CPR in each subinterval, while CCF is the proportion of time during which compressions were performed during the entire resuscitation. Some EMS systems have implemented choreographed approaches to resuscitation designed to optimize CCF and CPR ratio by limiting pauses with the goal of increasing ROSC rates. Advanced airway management has historically been a major focus of cardiac arrest management, but has recently been called into question, and may contribute to pauses in chest compressions and lower CCF. A recent simulated study of airway intervention in cardiac arrest showed that supraglottic airway (SGA) use significantly increased CCF compared to bag valve mask (BVM). The objective was to determine the average chest compression fraction and CPR ratio during resuscitation as a function of airway intervention: non-breather mask, BVM, endotracheal intubation, or SGA. **Methods:** Retrospective chart review of cardiac arrest patients between 1/1/2013 and 6/30/2013 in a busy urban EMS system using a choreographed pit crew resuscitation approach. Data were extracted from electronic medical records and resuscitation data, including detailed chest compression measures and airway interventions. The study endpoints were chest compression fraction and CPR ratio. **Results:** A total of 196 patients were included in the final analysis. There were a total of 416 airway interventions (an average of 2.1 per patient), with 133 non-breather, 157 BVM, 99 endotracheal intubation and 27 SGA. The average chest compression fractions were 87.1%, 94.2%, 92.7%, and 94.5%, respectively; average CPR ratios were 94.5%, 94.2%, 93.8%, and 93.1%. There were no statistically significant differences in

chest compression fraction or CPR ratio among the four studied airway interventions ($p = 0.5033$ and $p = 0.9116$ for chest compression fraction and CPR ratio respectively). **Conclusions:** The choice of airway management has no effect on the chest compression fraction or CPR ratio when used within a specific choreographed pit crew approach to cardiac arrest management.

40. SURVIVAL RATES AND DIAGNOSTIC ACCURACY OF OUT-OF-HOSPITAL CARDIAC ARRESTS AS DEFINED BY RESCUER FIRST IMPRESSION

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Background: Survival estimates in cardiac arrest vary widely and employ variable case definitions. The Utstein sudden cardiac arrest definition uses whether the arrest was witnessed, the rescuer impression of cardiac etiology, and presenting rhythm of ventricular fibrillation to identify specific populations with likely cardiac etiologies. In contrast, the World Health Organization (WHO) has defined sudden cardiac death using pre-arrest symptom history and comorbidities. We sought to determine the accuracy of (1) rescuer impression of cardiac cause, (2) Utstein sudden cardiac arrest, and (3) WHO sudden cardiac death in identifying cardiac etiology and compare the survival rates. **Methods:** Electronic patient care records, hospital charts, and autopsy reports were obtained for 649 patients, identified as prehospital attempted resuscitations in an urban setting from 1/1/2011 to 12/31/2012. We determined whether the rescuer had the primary impression of cardiac etiology, whether the arrest was witnessed, initial rhythm, and survival to hospital discharge. Cases were identified that met inclusion criteria for Utstein SCA and/or WHO SCD definitions. **Results:** Among 649 patients, 478 had rescuer presumed cardiac etiology. Of these, 70 met criteria for Utstein SCA and 202 met WHO SCD criteria. Among the Utstein cases, 71.4% (50/70) also met WHO criteria. In the WHO group, 32.8% (50/152) also met Utstein criteria. Overall survival to hospital discharge was 14% (92/649). Patients with rescuer primary impression of cardiac etiology had a survival rate of 12.1% (58/478). The Utstein survival rate was 37% (26/70). WHO patients had a survival rate of 24% (49/202). In cases with rescuer presumed cardiac etiology, postmortem examination confirmed cardiac cause of death in 50% of autopsied cases (63/126). The Utstein group autopsies confirmed cardiac cause of death in 66% (8/12). Among WHO autopsies, cardiac causes were reported in 68% (47/69). **Conclusions:** Both WHO and Utstein-defined cardiac arrests were associated with higher survival rates than initial rescuer presumed cardiac etiology and undifferentiated resuscitation groups. Both groups had similar rates of autopsy confirmed cardiac etiology. While selection bias could be significant in this analysis, further investigation could establish predictive accuracy of the case definitions.

41. THE RELATIONSHIP OF MAXIMUM TROPONIN VALUES POST OUT-OF-HOSPITAL CARDIAC ARREST WITH ELECTROCARDIOGRAPHIC FINDINGS, CARDIAC PROCEDURES AND SURVIVAL TO DISCHARGE: A SUB-STUDY OF ROC PRIMED

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Background: This study sought to describe the relationship between maximum troponin (Tn)

levels recorded within 48 hours post arrest and clinical outcomes in out-of-hospital cardiac arrest (OHCA) patients enrolled in the Resuscitation Outcomes Consortium (ROC) Prehospital Resuscitation using an Impedance valve and Early versus Delayed analysis (PRIMED) trial. **Methods:** A prospective observational cohort study of all treated non-traumatic OHCA patients enrolled in ROC PRIMED. Patients were classified based on first presenting in-hospital ECG as ST elevation myocardial infarction (STEMI) or not a STEMI (including NSTEMI). Peak Tn levels, evaluated on a logarithmic scale, were compared across patient and treatment characteristics using a t-test or ANOVA. The association between categories of Tn levels (<0.1 , $0.1-2$, >2) and survival to discharge was evaluated using logistic regression adjusted for Utstein predictors of survival and ROC site. **Results:** Of the 15,617 enrolled patients, 3,661 (23%) survived at least 48 hours, 17% (693) were STEMI, and 78% (3188) were not a STEMI with 5% unknown and 83% (3,460) with at least one Tn level measured. The mean (SD) age was 64.6 (15.9). The STEMI group had more men (74.5% STEMI, 62% not a STEMI) and was more likely to have an initial shockable rhythm (73% STEMI, 39% not a STEMI). In-hospital survival was higher with STEMI (OR 1.93, 95% CI 1.63-2.3, $p < 0.001$). The logarithm of Tn values was higher in STEMI patients ($p < 0.001$). Adjusted in-hospital survival for STEMI patients was significantly better in those patients with higher Tn values ($p = 0.01$). Adjusted in-hospital survival was significantly worse with higher Tn levels in the not a STEMI group ($p < 0.001$). When treated with reperfusion, adjusted survival in the not a STEMI group was significantly better than the survival rate without reperfusion (OR 3.6, 95% CI 2.4-5.4 for > 0.1 , $p < 0.001$). **Conclusion:** High Tn levels were associated with increased rates of reperfusion and better in-hospital survival in post-arrest patients with STEMI on first ECG. High Tn levels in not a STEMI patients post arrest were associated with decreased survival. Survival in not a STEMI patients was significantly higher when treated with reperfusion.

42. AMPLITUDE SPECTRUM AS A TOOL TO IDENTIFY THE CIRCULATORY PHASE OF VENTRICULAR FIBRILLATION

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Background: Ventricular fibrillation (VF) cardiac arrest (CA) is characterized by three time dependent phases: electrical (shorter than 4 min), circulatory (4-10 min) and metabolic (longer than 10 min). These phases reflect the progressive increase of myocardial ischemia and suggest the potentially optimal treatment. During the electrical phase, immediate defibrillation is likely to be successful, while during the circulatory phase, the success of defibrillation diminishes without CPR. In the metabolic phase, there is low likelihood of successful resuscitation and probably a longer CPR interval prior to defibrillation is necessary. In the out-of-hospital (OH) setting, most patients may have passed the electrical phase when EMS arrives. Identification of the VF phase may therefore facilitate the proper CPR treatment. In the current study, we used AMSA to determine if patients were in circulatory or in metabolic phase at EMS arrival. **Methods:** Data from an Utstein-compliant registry along with electronic ECG records were collected on consecutive adult non-traumatic OHCA patients treated by 2 EMS agencies over a 2-year period. Patients with bystander witnessed CA and with VF as initial CA rhythm were included ($n = 41$). AMSA was calculated in earliest pause without

compression artifacts, using a 2-sec ECG with a Tukey (0.2) FFT window. VF duration was calculated as the sum of the time interval from collapse to defibrillator on and the time interval from defibrillator on to first CPR interruption for defibrillation delivery. **Results:** VF duration ranged between 6.5 and 29.6 min (11.3 ± 4.1 min), with a corresponding AMSA between 2.1 and 16.4 mV-Hz (9.4 ± 4.2 mV-Hz). AMSA measured in the circulatory phase ($N = 19$) was significantly higher than that in the metabolic phase ($N = 22$) (8.14 ± 3.17 vs. 5.98 ± 2.88 , $p = 0.03$). Linear regression revealed that AMSA decreases by 0.22 mV-Hz for every min of VF. AMSA was able to predict circulatory phase with an accuracy of 0.7 in ROC area. An AMSA threshold of 10 mV-Hz was able to predict the circulatory phase with sensitivity of 32%, specificity of 95%, PPV of 86%, NPV of 62%, and overall accuracy of 66%. **Conclusions:** AMSA is a good indicator of downtime in bystander witnessed OHCA victims with initial rhythm of VF.

43. HEALTH-CARE PROVIDER PERSPECTIVES ON RESUSCITATION OF SUSPECTED DRUG-RELATED OUT-OF-HOSPITAL CARDIAC ARREST

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Background: In the U.S., out-of-hospital cardiac arrest from drug overdose (OD-OHCA) caused over 38,000 deaths in 2010. A study in Pittsburgh found that OD-OHCA patients differed demographically and in the resuscitation treatments they received, despite identical AHA resuscitation guidelines. We hypothesized that health-care provider perceptions affect decision-making in the treatment of OD-OHCA versus non-OD OHCA. **Methods:** The institutional review board of the University of Pittsburgh approved this study. We conducted this survey at the National Association of EMS Physicians 2013 Scientific Assembly. Physicians and non-physician health-care providers were given one of two surveys containing 19 questions pertaining to the respondents' affiliated EMS agencies, the estimated proportion of OD-OHCA as well as the drugs involved, and the respondents' belief about the treatments for OD- versus non-OD OHCA. **Results:** One hundred ninety-three respondents participated in this survey. Of the 193, 144 (75%) were physicians and 49 (25%) were non-physicians. Seventy-nine percent of physicians identified current status as a medical director and 76% of non-physicians identified as a paramedic. Participants estimated the average proportion of all month OHCA due to OD to be 3.9%. Participants ranked opioids, alcohol, antidepressants, and benzodiazepines as the most commonly utilized agents in OD-OHCA. Forty-two percent of physicians felt that the incidence of OD-OHCA was not changing while 53% of non-physicians felt the incidence was increasing. Seventy-eight percent of all respondents reported the use of naloxone during OD-OHCA resuscitation, while 12% reported administering naloxone during non-OD OHCA resuscitation. Eighty-three percent of physicians and 65% of non-physicians indicated that OD-OHCA patients had different demographics than non-OD OHCA, with primary reported differences being age, comorbidities, and socioeconomic status. Sixty-three percent of physicians and 69% of non-physicians felt that OD-OHCA patients should be treated differently, with primary differences being the incorporation of etiology-specific treatments, performing different CPR with a focus on airway support, and transporting earlier. **Conclusions:** When surveyed, physicians and non-physician providers report perceiving OD-

OHCA treatment, outcomes and patient demographics differently than non-OD OHCA and making different treatment decisions based on these perceptions. This may result in etiology-oriented resuscitation in the out-of-hospital setting, despite the lack of OD-specific resuscitation guidelines.

44. MILD THERAPEUTIC HYPOTHERMIA AND GOOD NEUROLOGICAL RECOVERY AFTER OUT-OF-HOSPITAL CARDIAC ARREST BY PRIMARY ECG RHYTHM: A NATIONWIDE OBSERVATIONAL STUDY

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Background: Mild therapeutic hypothermia (MTH) has been known to be associated with good neurological recovery after out-of-hospital cardiac arrest (OHCA) with witnessed ventricular tachycardia and fibrillation in randomized controlled trial. MTH has been controversial about the effect on OHCA with non-shockable rhythms. The study aims to determine the association between MTH by ECG rhythm and good neurological recovery after OHCA. **Methods:** Adult patients with presumed cardiac etiology and known outcomes were collected from nationwide cardiac registry between 2008 and 2012, excluding cases with death prior to hospital admission. Variables included age, gender, place of the event, witness, bystander cardiopulmonary resuscitation, metropolitan versus non-metropolitan, response time, defibrillation by ambulance providers, levels of emergency department, reperfusion therapy, primary ECG group such as ventricular fibrillation/tachycardia (VF/VT), pulseless electrical activity (PEZ), and asystole. MTH was defined as a case receiving hypothermia procedure regardless of potential methods (external cooling, internal cooling, or intravascular cooling) for at least 12 hours. Main outcome was good neurological recovery with cerebral performance category 1 and 2 measured by hospital medical record review. Multivariable logistic regression analysis was performed adjusting for potential confounders without interaction terms between MTH and primary ECG rhythms (simple model) and with interaction term (interaction model) to calculate adjusted odds ratios (AORs) and 95% confidence intervals (CIs). **Results:** Of 78,837 adult OHCA with cardiac etiology, 8,605 patients (10.9%) survived to admission. Of these, survival to discharge and good neurological recovery was 37.6% and 14.5%, respectively. MTH was performed in 1,148 patients (13.4%) in total patients, 18.5% in VT/VF ($n = 1011$), 20.4% in PEA ($n = 729$), and 11.8% in asystole ($n = 6,865$), respectively. Simple model showed a significant association between MTH and good neurological recovery (AOR = 1.30, 95% CI = 1.08-1.56). In an interaction model, AOR of MTH and interaction effect with VT/VF, PEA, and asystole was 1.49 (1.47-2.12), 1.32 (1.08-1.62), and 1.17 (0.94-1.45), respectively. **Conclusions:** MTH was significantly associated with good neurological recovery in patients who survived OHCA but the effect was different by ECG rhythm. MTH was not beneficial in the group of patients with asystole (70.7% of patients receiving MTH) in a nationwide observational study.

45. MILD THERAPEUTIC HYPOTHERMIA AND GOOD NEUROLOGICAL RECOVERY AFTER OUT-OF-HOSPITAL CARDIAC ARREST BY PREHOSPITAL RETURN OF SPONTANEOUS CIRCULATION: A NATIONWIDE OBSERVATIONAL STUDY

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Background: Mild therapeutic hypothermia (MTH) has been known to be associated with good neurological recovery after out-of-hospital cardiac arrest (OHCA). Prehospital return of spontaneous circulation (P-ROSC) is associated with better hospital outcomes rather than ROSC at emergency department (ED-ROSC). It is unclear whether MTH has an interaction with P-ROSC or ED-ROSC for good neurologic recovery or not. The study aimed to determine the association between MTH by P-ROSC and good neurological recovery after OHCA. **Methods:** Adult patients with presumed cardiac etiology were collected from nationwide cardiac registry between 2008 and 2012, excluding cases with death prior to hospital admission. Variables included age, gender, place, witness, bystander cardiopulmonary resuscitation, metropolitan, response time, prehospital defibrillation, levels of ED, reperfusion therapy, primary ECG, and P-ROSC versus ED-ROSC. MTH was defined as a case receiving hypothermia procedure regardless of potential methods for at least 12 hours. The main outcome was good neurological recovery with cerebral performance categories 1 and 2 measured by hospital medical record review. Multivariable logistic regression analysis was performed adjusting for potential confounders without considering interaction terms between MTH and P-ROSC (simple model) and with considering interaction term (interaction model) to calculate adjusted odds ratios (AORs) and 95% confidence intervals (CIs). **Results:** Of 78,837 adult OHCA with cardiac etiology, 8,605 patients (10.9%) survived to admission. Of these, good neurological recovery was 14.5%; 54.2% in P-ROSC and 8.3% in ED-ROSC ($p < 0.001$), and 13.3% in non-MTH and 21.7% in MTH ($p < 0.001$), respectively. MTH was performed in 13.4% of total patients, 15.9% in P-ROSC ($n = 1,170$) and 12.9% in ED-ROSC ($n = 7,435$), respectively. A simple model showed a significant association between MTH and good neurological recovery (AOR = 1.34, 95% CI = 1.09-1.62). In an interaction model, AOR of MTH and interaction effect with P-ROSC and ED-ROSC were 0.97 (0.67-1.38) and 1.43 (1.14-1.79), respectively. **Conclusion:** MTH was significantly associated with good neurological recovery in patients who survived OHCA but the effect was different by P-ROSC versus ED-ROSC. Prehospital ROSC group showed a much higher good neurologic recovery. MTH was significantly beneficial in patients group with ROSC at ED (86.4% of patients receiving MTH), not P-ROSC group, in a nationwide observational study.

46. THE SCENE TIME INTERVAL AND BASIC LIFE SUPPORT TERMINATION OF RESUSCITATION RULE IN ADULT OUT-OF-HOSPITAL CARDIAC ARREST IN AN EAST ASIAN METROPOLITAN EMERGENCY MEDICAL SERVICES SYSTEM

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Background: The basic life support termination of resuscitation (BLS TOR) rule has been studied to reduce the unnecessary use of emergency medical service resources. The BLS TOR rule had been validated and proven to show a high predictive value in North America where patients usually receive longer cardiopulmonary resuscitation (CPR). East Asian EMSs have a scoop and run model, including an obligatory transportation protocol, after a short period of CPR at the intermediate service level. We validated the BLS TOR rule and tested it by investigating the scene time interval at a metropolitan

EMS in Korea. **Methods:** We used the OHCA database of Seoul metropolitan from January 2011 to December 2012, which is composed of hospital and ambulance data that contained the Utstein risks and hospital outcomes. We included EMS-treated and 18-year or older victims. Cases that occurred in the ambulance and with incomplete information were excluded. The primary and secondary outcomes were hospital mortality and poor neurologic outcome (cerebral performance category 3, 4, or 5). We tested the predictive performance of the BLS TOR rule by calculating the sensitivity (SS), specificity (SP), and the positive and negative predictive values (PPV and NPV). We supplemented and tested the rule according to the scene time interval group by one min. for sensitivity analysis to achieve 100% specificity and a positive predictive value. **Results:** Of the 7,458 OHCA patients, we enrolled 4,835 patients, excluding the following: children (n = 168), non-cardiac etiology (n = 1,641), not treated by EMS (n = 316), occurred in ambulance (n = 283), and incomplete information (n = 283). 3,361 (69.5%) cases met all 3 criteria of the BLS TOR rule. Of these, 3,224 (95.9%) were dead at discharge (SS-73.5%, SP-69.6%, PPV-95.9%, and NPV-21.3%) and 3,342 (99.4%) showed poor neurologic outcome at discharge (SS-75.2%, SP-89.9%, PPV-99.4%, and NPV-11.5%). The cut-off scene time interval for 100% SS and PPV was more than 20 minutes for survival to discharge and more than 14 minutes for good neurological recovery. **Conclusions:** The BLS TOR rule showed relatively lower SS and PPV in a retrospective validation study in Korea than the scoop and run model. To achieve higher performance, modified TOR rules using scene time interval.

47. FLOOR LEVEL AND OUTCOMES AFTER OUT-OF-HOSPITAL CARDIAC ARREST

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Background: In a scoop and run emergency medical service (EMS) model, cardiopulmonary resuscitation (CPR) during transport has been known to be unsafe and associated with poor quality. High-rise buildings have small elevators, which are barriers to accessing to the scene and to running back to the ambulance. It is unclear whether the floor level of the scene in a building is associated with hospital outcomes after out-of-hospital cardiac arrest (OHCA) or not. We aimed to determine the association between the floor level and outcomes after OHCA. **Methods:** We used a nationwide OHCA registry (2008-2012) from Korea, which was based on data from EMS patient care report and medical record review, excluding patients with unknown location or floor level, location out of a building, and non-cardiac etiology. Variables included age, gender, place, witness, bystander CPR, metropolitan, response and transport time, prehospital defibrillation, ED levels, primary ECG, and floor level. The first floor level was used for reference. Primary and secondary outcomes were survival to discharge and good neurological recovery (cerebral performance categories 1 and 2). Multivariable logistic regression analysis was performed adjusting for potential confounders for outcomes to calculate adjusted odds ratios (AORs) and 95% confidence intervals (CIs). **Results:** The total number of EMS-assessed OHCA was 112,895. Of these, analysis was done for eligible patients (n = 21,535), excluding patients with non-cardiac (n = 32,641), unknown information on indoor place or place out of building (57,943), and unknown floor level (n = 786). Survival to discharge and good neurological recovery were 3.6% (4.5% for first floor, 3.5% for 2nd to 5th floor, 3.2% for 6th to 20th, 4.3% for 20th and higher) and 1.3%, (1.6% for first floor, 1.2% for 2nd to 5th floor, 1.1% for 6th to

20th, 1.3% for 20th and higher), respectively. Adjusted OR (95%CI) by one floor unit increase was 0.98 (0.97-0.99) for survival to discharge and 0.98 (0.95-1.00) for good neurological recovery respectively. **Conclusion:** An increase in floor level of OHCA incidence location was associated with worse survival to discharge rate. It may be explained by lower quality CPR during transport from the high-rise building.

48. CARE FOR CARDIAC ARREST ON GOLF COURSES: STILL NOT UP TO PAR?

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Background: Early CPR and use of automated external defibrillators (AEDs) have been shown to improve cardiac arrest (CA) outcomes, yet popular public venues don't have AEDs. Placement of AEDs in public recreational locations has been advocated for more than a decade, with a seminal publication in *Golf* magazine in 1999 calling for their use. The objective was to describe the incidence of cardiac arrests at Michigan golf courses and assess the response readiness of their staff. **Methods:** We performed a retrospective study of CA in golf courses in Michigan, from 2010 to 2012. Cases were identified using a word search of public location CA from the Michigan EMS Information (MI-EMSI) database. Cases with "golf" were manually reviewed and identified using Google Maps. We conducted a structured telephone survey for each incident, capturing location demographics, course preparedness for emergencies, including CPR training and AED placement, a description of events and whether CPR was performed, and if AED was used. EMS Utstein data were collected from MI-EMSI. Descriptive data are presented. **Results:** During the study period, there were 14,666 CAs recorded, of which 26 (.18%) occurred on 25 golf courses (1 arrest/121 courses/year). All but one occurred between May and October, yielding a golf season rate of 1 arrest/60 courses/golf season. Two (7.7%) courses required CPR/ AED training of staff and six (23.1%) had AEDs on site. Almost all (96.2%) patients were male, their mean age was 66.3 (range 45-85), 68% had VF or VT, and six arrested after EMS arrival. Median time from 9-1-1 call to EMS arrival at the patient was 11 minutes (range 4-20.6). Although 14 (53.8%) patients received bystander CPR, CPR was performed by course staff on two patients, and an AED was placed on one patient. Sustained ROSC at ED arrival was obtained in 9 (34.6%) patients. **Conclusion:** Cardiac arrest on Michigan golf courses is rare, but seasonally adjusted rates are similar to other public locations. Preparedness for and response during a CA is suboptimal with AED use rare. Despite more than a decade of advocacy, response to golf course cardiac arrest is still not up to par.

49. GENDER DIFFERENCES IN ACCESS TO POST-ARREST CARE: A SPARC NETWORK COHORT STUDY

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Background: The objective of this study was to explore gender disparities in the delivery of targeted post-arrest care after out-of-hospital cardiac arrests (OHCA). **Methods:** A prospective cohort study of consecutive adult OHCA with a return of spontaneous circulation for at least 20 minutes and without advance direc-

tives, presenting to any of the 34 hospitals participating in the Strategies for Post-Arrest Care Network. The primary outcome was the proportion of post-OHCA patients receiving angiography with or without percutaneous coronary intervention (PCI) within 90 minutes of documented ST-elevation myocardial infarction (STEMI) on a 12-lead ECG at admission to hospital. Secondary measures included rates of targeted temperature management (TTM) and withdrawal of life-sustaining therapy. **Results:** Of the 1,053 treated adult OHCA patients meeting the inclusion criteria, 336 were women and 717 were men, with mean ages of 68 (17 for women vs. 66 (15) for men (p = 0.07). Women were less likely to have favourable Utstein predictors of survival (p < 0.02) and STEMI post arrest (58 [18%] women vs. 208 [30%] men, p < 0.0001). There was no observed gender difference between achieving the time target for angiography with or without PCI for STEMI positive (18 [31%] vs. 79 [38%], p = 0.33). Women who were STEMI negative were less likely to receive coronary angiography (22 [8%] vs. 74 [15%], p = 0.006) or PCI (7 [3%] vs. 30 [6%], p = 0.04). Eligible women were less likely to receive TTM (147 [78%] vs. 382 [85%], p = 0.04). Women were more likely to have life-sustaining therapy withdrawn at any time (127 [38%] vs. 221 [31%], p = 0.03) and within 72 hours (78 [61%] vs. 109 [49%], p = 0.03). Women were less likely to survive to discharge (OR 0.67, 95% CI 0.5-0.9, p = 0.005); however, this difference disappeared when adjusted for Utstein predictors of survival, which were more common in men (OR 1.2, 95% CI 0.9-1.6, p = 0.32). **Conclusion:** The frequency of meeting the time targets for STEMI post OHCA was similar for both men and women. OHCA in women was associated with unfavourable predictors of survival, increased rates of early withdrawal of life-sustaining therapy, reduced rates of TTM and less diagnostic testing when STEMI was negative on ECG. Despite these differences, adjusted survival was similar for both genders.

50. DURATION OF PREHOSPITAL RESUSCITATION FOR ADULT OUT-OF-HOSPITAL CARDIAC ARREST: NEUROLOGICALLY INTACT SURVIVAL APPROACHES OVERALL SURVIVAL DESPITE EXTENDED EFFORTS

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Background: Out-of-hospital cardiac arrest (OHCA) guidelines suggest resuscitation beyond 30 minutes may be futile. Few studies address neurologic outcome for survivors of extended OHCA. The duration of prehospital resuscitation (DOR) that yields a reasonable probability of neurologically intact survival (NIS) is unknown. We assess whether DOR affects NIS from OHCA. **Methods:** We conducted a retrospective cohort study of all OHCA patients in our urban/suburban advanced life support EMS system (pop 950,000) from 2005 to 2012. Excluded were resuscitations not attempted, age < 16, trauma patients, and EMS-witnessed arrests. DOR was measured from time of dispatch to end of prehospital resuscitation, defined by first return of spontaneous circulation, en-route hospital, or death. Primary outcome was NIS, defined as cerebral performance category (CPC) 1 or 2 at hospital discharge. Multivariate logistic regression determined the odds ratios with 95% confidence intervals (CI) for both survival and NIS, adjusted for DOR and factors determined to have a significant relationship with NIS at the univariate level. **Results:** Of 2,905 eligible OHCA patients were at a mean age of 64.6 years (SD = 17.0), male 60.1%, bystander witnessed 38.9%,

and had bystander CPR 37.2%. Overall, 362 survived (12.5%) and 300 had NIS (82.9% of survivors). Overall median DOR was 38 min (IQR 29-48), with median DOR for NIS of 24 min (IQR 18-32). The 90th percentile for NIS was 40 min. Beyond 40 min, 29/42 survivors (69%, 95% CI 54-81%) were neurologically intact. The longest resuscitation that achieved NIS was 73 min. Controlling for resuscitation protocol changes over time, the adjusted OR (95% CI) was 0.91 (0.90-0.92) for both survival and NIS. Other significant predictors of NIS across models were initial rhythm, age, bystander witness, therapeutic hypothermia, and absence of advanced airway. Limitations include the observational nature of these results. **Conclusions:** In a retrospective analysis of OHCA, DOR is associated with declining survival and NIS, with NIS approximating the overall survival curve. DOR was within 40 minutes from time of dispatch for 90% of NIS. A large number of patients survived neurologically intact with DORs greater than previous guidelines would suggest. Further study should examine factors predictive of NIS in longer resuscitations.

51. INITIAL GLASGOW SCORE UPON ARRIVAL AT THE EMERGENCY DEPARTMENT AFTER OUT-OF-HOSPITAL CARDIAC ARREST IS NOT A PREDICTOR OF DISCHARGE NEUROLOGIC STATUS

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Background: Out-of-hospital cardiac arrest (OHCA) remains a significant public health problem, and few emergency department (ED) prognostic factors have been characterized that accurately predict discharge neurologic status. The objective of this study was to determine the prognostic value of the initial Glasgow Coma Score (GCS) upon ED arrival for OHCA patients who achieved return of spontaneous circulation (ROSC) in the field. **Methods:** This was a retrospective one-year study of all adult (age > 18) non-traumatic OCHAs in Los Angeles, California between July 1, 2011 and July 1, 2012 who achieved ROSC in the field. The primary outcome measure was neurologically intact survival, which was defined as survival to hospital discharge with a cerebral performance category (CPC) score of 1 or 2. **Results:** There were 1,531 consecutive cardiac arrest patients on whom resuscitation was attempted and which appeared to be a primary cardiac event. 573 (37.4%) patients achieved ROSC, of whom 303 had complete outcome data. Of these, 109 (35.9%) survived to hospital discharge, including 75 (24.7%) patients who were neurologically intact. Of these patients, 73 had a documented GCS upon ED arrival. 58 (79.5%) patients presented with a GCS of 3, 65 (89.0%) presented with a GCS <9, 1 (1.4%) between 10 and 13, and 7 (9.6%) with a GCS of 14-15. Therapeutic hypothermia was provided to 41 (56.2%) patients with a good neurologic outcome. **Conclusion:** The initial GCS upon ED arrival for OHCA patients does not predict neurologic outcome, since almost 80% of patients who survived neurologically intact arrived comatose. Aggressive resuscitative measures, including therapeutic hypothermia, should be performed regardless of the presenting GCS.

52. INCIDENCE AND OUTCOMES OF RE-ARREST FOLLOWING OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Re-arrest (RA) occurs when a patient experiences cardiac arrest after successfully achieving return of spontaneous circulation (ROSC). The incidence and outcomes of RA following out-of-hospital cardiac arrest (OHCA) have been estimated in limited local studies. We sought to investigate the incidence

and outcomes of RA over a broad geographic area. **Methods:** This retrospective study was approved by the University of Pittsburgh institutional review board. We obtained case data from EMS-treated, non-traumatic OHCA from the Resuscitation Outcomes Consortium, a multisite clinical research network conducting population level surveillance of OHCA in 11 cities in the US and Canada. The study cohort comprised all OHCA cases surveilled between 2006 and 2008 at ROC sites and having prehospital ROSC. We used three methods to ascertain RA incidence among these cases: direct signal analysis, indirect cardiopulmonary resuscitation (CPR) process analysis, and emergency department arrival vital status. RA incidence was estimated as the proportion of cases with ROSC that experience RA. Regional RA estimates were compared with the chi-squared test. Multivariable logistic regression was used to assess the relationship between RA and survival to hospital discharge, and multivariable Cox regression was used to assess the relationship between RA and survival over time. **Results:** Out of 18,937 cases of EMS-assessed OHCA captured between 2006 and 2008, 11,456 (60.5%) cases were treated by EMS and 4,396 (38.4%) had prehospital ROSC. Of these, sufficient data were available for RA ascertainment in 3,253 cases, with 568 (17.5%) experiencing RA. Regional RA incidence varied significantly from 10.2% to 21.2% ($p < 0.001$). RA was significantly inversely associated with survival (OR: 0.19, 95%CI: 0.14-0.26). Cases with RA were more likely to die during 90-day follow-up than cases without (HR: 1.55, 95%CI: 1.29-1.88). **Conclusions:** In this geographically broad and inferentially conservative analysis, RA occurred on average in 1 of every 6 successfully resuscitated patients, though incidence varied significantly across 10 sites in North America. RA was found to be inversely associated with survival to hospital discharge and directly associated with risk of death within 90 days.

53. IMPACT OF CHECKLISTS ON PERI-INTUBATION CARE IN EMERGENCY DEPARTMENT TRAUMA PATIENTS

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Background: Checklists have been increasingly used to improve several metrics of critical care. Proper peri-intubation care including use of appropriate induction agents and post-intubation sedation is crucial when performing endotracheal intubation (ETI) on critically ill patients, however, little is known regarding the effectiveness of checklists on peri-intubation care. We hypothesized that utilization of a checklist would improve peri-intubation care. **Methods:** This study was a quality improvement effort in our facility and deemed exempt by the institutional review board at our university. We performed a retrospective review of all trauma patients intubated in the ED of an academic, urban, level 1 trauma center from November 2010 through October 2012. A peri-intubation checklist was instituted on November 1, 2011 to guide peri-intubation care, which directed providers to various aspects of ETI care. The primary outcome examined pre- and post-checklist rates of post-intubation sedation, in the form of anxiety, analgesia or both. Secondary outcomes included rates of rapid sequence intubation (RSI) and patient outcomes (mortality, lengths of stay, etc.). Data were compared using chi-squared and t-test when appropriate. **Results:** During the 2-year study period, 187 trauma patients underwent ETI in the ED, 90 pre-checklist and 97 post-checklist. A trend was noted towards increased post intubation analgesia from 14.4% pre-checklist to 27.8% post-checklist (p -value 0.054). Sedation administration following intubation was not

different between pre- and post-checklist patients (63.3% vs. 69.1%, $p = 0.407$). RSI use was greater after implementation of the checklist (75.6% vs. 90.7%, $p = 0.005$). We found no difference between pre- and post-checklist first pass success rates (88.8% vs. 81.3%, $p = 0.356$) or post-ETI hemodynamic parameters (heart rate, blood pressure and oxygen saturation.) There were no differences in median number of ventilator days, length of ED stay, length of ICU stay or mortality. **Conclusion:** Peri-intubation checklists result in higher rates of RSI in ED trauma patients but do not alter other metrics of peri-intubation care. Even with the assistance of a checklist post-intubation analgesia and sedation use remain low.

54. THE IMPACT OF VIDEO LARYNGOSCOPY ON INTUBATION SUCCESS RATES DURING CRITICAL CARE TRANSPORT

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Background: Prehospital providers often need to perform intubation under less-than-optimal conditions, making this challenging skill even more difficult. Previous studies have shown the utility of video laryngoscopy, but most have been carried out in an in-hospital setting. We examined the impact of adding video laryngoscopy to the airway management protocol of a critical care transport team. We hypothesized that video laryngoscopy would result in a higher overall intubation success rate as well as fewer unsuccessful attempts compared to direct laryngoscopy. **Methods:** We performed a 2-year retrospective before-and-after study of flight records from a single critical care transport program. Video laryngoscopy was not available during the first year of the study; in the second year, per protocol, initial attempts were required to be performed with a C-MAC video laryngoscope. A single investigator reviewed all flight records, abstracting pertinent airway management variables and success rates. Data were analyzed utilizing both linear and logistic regression models. **Results:** During the study period, 60 intubations (51.7%) were performed with direct laryngoscopy and 56 were performed using video laryngoscopy. Of the patients who underwent direct laryngoscopy, four patients (6.7%) were unable to be intubated and required the placement of a rescue device; there were no instances of rescue device placement with the use of the C-MAC. Video laryngoscopy was not, however, found to be statistically more successful than direct laryngoscopy ($p = 0.12$). In addition, a linear regression, taking into account multiple possible confounders, found that the odds of needing multiple attempts in order to successfully intubate was not statistically higher with direct laryngoscopy (OR = 1.22, 95% CI = 0.43-3.43). The only variable that proved to have a significant impact on intubation success was Cormack-Lehane score of I or II (OR = 4.45, 95% CI = 1.60-12.38); there was an independent association between use of the video laryngoscope and lower Cormack-Lehane scores (OR = 3.62, 95% CI = 1.46-8.99). **Conclusions:** In this study there was no statistically significant improvement in intubation success rate or number of attempts when comparing direct and video laryngoscopy. The CMAC offered a better view of the glottis, as indicated by lower Cormack-Lehane scores.

55. THE IMPACT OF SUPRAGLOTTIC AIRWAY USE ON OUT-OF-HOSPITAL TRACHEAL INTUBATION

Michael Hilton, Max Wayne, Christian Martin-Gill, University of Pittsburgh

Background: Endotracheal intubation is the primary method to definitively secure a compromised airway and is a key component of advanced life support care provided

by paramedics. However, paramedics infrequently perform this procedure and may have inadequate training and retention. Supraglottic airway devices provide an alternate method of airway management and have increasingly been used for primary airway control. The impact of the availability of supraglottic airway devices on the performance of out-of-hospital endotracheal intubation is unknown. We aimed to determine whether out-of-hospital endotracheal intubation success rates have changed before and after the introduction of supraglottic airway devices. **Methods:** We retrospectively reviewed 4,100 prehospital medical records from 16 urban, suburban and rural Emergency Medical Services (EMS) agencies between 2005 and 2012. Cases involving an advanced airway procedure were included ($n = 3545$), excluding cases from 2007 as a run-in period when supraglottic devices were introduced in these EMS agencies. First pass success and final definitive airway were identified. The proportion of cases with first-pass success and the proportion of cases with final definitive airway being intubation were compared before and after 2007 using Pearson's chi-squared analysis, using a p -value of <0.05 . We further describe the number and type of all advanced airway devices placed per year. **Results:** Of the 3,545 cases, 3,299 (93%) had an intubation attempt and 639 (18%) had a supraglottic device attempt. There was no significant change in proportion of cases with first-pass intubation success rate before versus after the introduction of supraglottic airways (59% vs. 59%, $p = 0.808$). However, there was a significant change in the proportion of cases in which the final airway was orotracheal intubation (74% vs. 68%, $p = 0.005$). **Conclusion:** We found no change in first-pass success rate of prehospital orotracheal intubation before versus after the introduction of advanced supraglottic devices. However, fewer patients ultimately received orotracheal intubation, indicating that supraglottic devices may primarily provide an alternative to further intubation attempts as a means to secure an airway in the prehospital setting.

56. EVALUATION OF THE KING VISION VIDEO LARYNGOSCOPE IN PARAMEDICS USING LEVITAN AIRWAY TRAINERS

Mike Gonzalez, Guy Gleisberg, Kevin Traynor, Mark Escott, Baylor College of Medicine, Cypress Creek EMS

Background: Endotracheal intubation (ETI) is a critical and challenging airway management skill performed by Emergency Medical Services (EMS). Airway manikins are widely used to train medical personnel on intubation and maneuvers. Patient simulators have inevitably become the standard for training as well for airway device evaluation. The objective was to determine the first-attempt success rates and characteristics of the King Vision video laryngoscope (KVL) using a novel difficult airway simulator, the Levitan Airway Training Series manikins (Levitan). **Methods:** Following institutional review board approval, two suburban EMS services received training on the KVL. After a comprehensive didactic and a hands-on trouble shooting session, each participant was asked to perform a series of ETIs. Each participant was tested on ETI utilizing six Levitan manikins by means of a randomized schema then a Laerdal AT Kelly Torso manikin (Laerdal) with a cervical collar. Each participant completed this randomized sequence twice; once using the KVL channel blade (CB) and once using the KVL non-channel blade (NCB) and stylet. First-attempt success rates, times of placement, Cormack-Lehane (C-L) and Percentage of Glottic Opening (POGO) scores were recorded. **Results:** 180 paramedics performed 2,520 intubations utilizing both the CB and NCB KVL. Of those, 2,160 were performed

on Levitan and 360 on Laerdal. The average first-attempt success rate for both groups was principally equivalent for Levitan (98% CB and 97% UCB) and Laerdal (97% CB and 98% NCB). The average C-L grade visualization was worse for both Levitan (2.0 CB and 2.0 UCB) versus Laerdal (1.0 CB and 1.0 UCB). Documented POGO was higher for Laerdal (96 CB and 96 for NCB) than for Levitan (84 CM and 85 NCB). The mean time of placement was greater for the Levitan (17 seconds CB and 21 seconds NCB) opposed to Laerdal (14 seconds CB and 13 seconds NCB). **Conclusions:** The Levitan airway trainers created a poorer view with lower C-L and POGO than the Laerdal trainer. However, first pass success of the KVL was essentially the same in the Laerdal and Levitan airway trainers. Additional prehospital studies are required to understand if this manikin training can translate into daily clinical practice.

57. CHANGES IN INTUBATION SUCCESS OVER THE FIRST YEAR WITH VIDEO-ASSISTED LARYNGOSCOPY

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Background: Research to date has supported the use of video-assisted laryngoscopy (VAL) prehospitally. Our protocol states that VAL is to be used as the first-line method for all intubations. We sought to determine how the ALS providers' comfort with VAL protocol and proficiency with intubation changed over the course of the first year in which first-attempt VAL intubation was protocol. Design: Retrospective cohort. Setting: A large, suburban, hospital-based ALS service that responds to about 20,000 calls per year. Protocol: VAL (the Glidescope) was introduced on all ALS vehicles and providers were trained in its use. Protocols were changed so that VAL was the first-line method for all intubations. The prehospital medical records of all intubated patients were reviewed. We calculated the rate of compliance with the VAL protocol, the rate of successful intubation on the first attempt, and rate of overall intubation success. We compared rates for the first 3 months after the protocol change with the rates for the last 3 months of the year. The differences between the rates and 95% confidence intervals (CI) were calculated. **Results:** Out of 20,922 ALS calls in the year, there were a total of 473 intubation attempts. The overall rate of intubation success was 90% (CI: 87-93). In the first 3 months there were 108 intubation attempts versus 112 in the last 3 months. The compliance with the VAL protocol was 81% in the first 3 months and 91% in the last 3 months; difference = 10% (CI: 1, 19). For the patients in which the VAL protocol was followed, the rate of intubation on the first attempt for the first 3 months was 80% and for the last 3 months was 79%; difference = -1% (CI: -13, 11). In terms of overall intubation success, the success rate for the first 3 months was 97% and for the last 3 months was 85%; difference -12% (CI: -20, -4). **Conclusion:** Although compliance with the protocol increased over the year, overall intubation success decreased significantly. The reason for this surprising result is unclear and requires further investigation.

58. VIDEO VS. DIRECT LARYNGOSCOPY: MULTI-SITE REVIEW OF THE FOUR-MONTH RUN-IN PERIOD BY PARAMEDICS

Mark Escott, Guy Gleisberg, Kevin Traynor, Michael Gonzalez, Brett Monroe, Baylor College of Medicine, Cypress Creek EMS

Background: Endotracheal intubation is a critical and challenging airway management skill performed by emergency medical services (EMS). Use of video laryngoscopy (VL) is ever-

increasing, particularly in the prehospital setting. Presently, a paucity of research exists comparing VL to direct laryngoscopy (DL) and subsequent first-attempt success rates (FASR). The objective was to measure and evaluate paramedics FASR and key performance characteristics of DL and VL in the prehospital environment using the King Vision video laryngoscope (KVL). **Methods:** After institutional review board approval and written informed consent obtained from paramedics, this prospective study included all consecutive intubations between March 18, 2013 through August 14, 2013 employing a standardized protocol. KVLs were placed on half of the vehicles as the primary device with DL as a backup within two suburban EMS systems and rotated monthly. Preceding deployment, paramedics received a 4-hour KVL didactic, trouble-shooting and manikin training utilizing the Levitan Airway Training Series by means of a randomized schema then a Laerdal AT Kelly Torso with a cervical collar. Each participant completed this sequence twice; once using the KVL channel blade and once using the KVL non-channel blade and stylet. Additionally, paramedics completed weekly manikin competency training on both VL and DL. Cormack-Lehane (C-L), FASR, primary failures (PF), and percentage of glottic opening (POGO) scores were recorded. **Results:** A total of 227 intubations were performed by 153 (61%) paramedics who had a mean experience with DL of 9 years, and 0.33 years with KVL. DL was utilized for 116 (51%) cases. The FASR rate was KVL 79(71%) and DL 75(65%) (95% CI: -0.056-0.183). The C-L grade I or II view achieved was KVL 86(77%) and DL 81(70%) (95% CI: -0.038-0.188). POGO scores of 80% or greater were KVL 80(72%) and DL 60(52%) (95% CI: 0.077-0.321). Frequent PF DL 16(38%) inability to visualize anatomy and KVL 13 (41%) secretions/blood/vomit. **Conclusions:** KVL appears to be at least as safe and effective as DL during a 120-day phase-in period with appropriate initial and ongoing competency training. Further long-term prehospital studies are warranted to evaluate KVL as a primary device for paramedic intubation.

59. AIRWAY MANAGEMENT PRACTICES IN ADULT NON-TRAUMATIC CARDIAC ARREST IN A LARGE, URBAN EMS SYSTEM

Jeffrey Goodloe, Annette Arthur, R Peyton Holder, William Murry, Jacob Witmer, Larry Higgins, Stephen Thomas, University of Oklahoma

Background: Emergency medical services (EMS) care confers distinct impact upon survivability from sudden cardiac arrest. Many studies have been conducted regarding EMS interventions for cardiac arrest with aim to correlate survival improvements. Fewer studies have been published detailing a broader analysis of intervention patterns in these patients. This study's purpose was to focus upon airway management practices by EMTs and paramedics in a sizeable cohort of adults suffering non-traumatic cardiac arrest, treated in a large, urban EMS system in the southwestern United States. The study EMS system utilizes standing order protocols for airway management that enable EMTs to insert a supraglottic airway if bag valve mask (BVM) ventilation proves procedurally ineffective and that enable advanced EMTs and paramedics to either insert a supraglottic airway or endotracheally intubate. There is a limit of three intubation attempts per patient specified by protocol. **Methods:** Retrospective chart review of consecutive patient encounters involving initiation of cardiopulmonary resuscitation for adults (defined as 18 years of age or greater) with non-traumatic cardiac arrest occurring January 1, 2012 to January

1, 2013 in the study EMS system. **Results:** In the 12 month study period, 1,042 adult patient encounters involved cardiopulmonary resuscitation initiated by EMS professionals for non-traumatic cardiac arrest. 602/1,042 (57.8%) patients were male. Mean patient age was 63.2 years, 79.6% patients being 50 years of age or older. BVM device utilization was documented in 976/1,042 (93.7%) resuscitations. The supraglottic airway utilized in the study EMS system was the King LT-D, placed in 227/1,042 (21.8%) resuscitations, successfully placed on first attempt in 219/227 (96.5%) uses. Only 7 attempts at supraglottic airway placement proved unsuccessful within 3 attempts. Endotracheal intubation was achieved in 785/1,042 (75.3%) resuscitations. There were 53/785 (6.8%) instances of extubation, 37/53 (69.8%) due to loss of continuous waveform capnography post-intubation. All patients in the cohort had documented achievement of oxygenation and ventilation. **Conclusions:** In a sizeable adult cohort with EMS resuscitation for non-traumatic cardiac arrest, airway management is primarily by BVM device preceding endotracheal intubation performed by advanced EMTs and paramedics. Nearly one-quarter of studied patients had airway management involving supraglottic airway placement.

60. PREHOSPITAL AIRWAY MANAGEMENT IN MAJOR TRAUMA AND TRAUMATIC BRAIN INJURY BY CRITICAL CARE PARAMEDICS

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Background: Prehospital endotracheal intubation (ETI) in major trauma and traumatic brain injury (TBI) remains contentious. Observational studies have highlighted potential risks associated with prehospital RSI, including hypoxemia ($SpO_2 < 90\%$), hyperventilation, or hypotension ($SBP < 90$ mmHg). We sought to characterize peri-intubation physiology in major trauma and brain-injured patients who underwent ETI by critical care flight paramedics (CCP) whose training is predicated on evidence-based guidelines, targeting specific peri-intubation oxygenation, ventilation, and hemodynamic goals. **Methods:** We performed a retrospective cohort study using the Provincial Airway Database for the British Columbia Ambulance Service (BCAS). Descriptive statistics were used to characterize consecutive patients who underwent ETI by Vancouver-based CCPs from January 2009 to June 2010. **Results:** Over an 18-month period, 104 patients underwent ETI of which 68 sustained major trauma and/or TBI. Of these, 22 were male with a mean age of 38 years (range 6-75). Overall ETI success rate was 93.2% (95%CI ± 4.8). Median attempts at laryngoscopy were 2 (IQR 1-3). Fifty-eight (85%) and 53 (78%) of these patients had a systolic blood pressure (SBP) ≥ 90 mmHg and/or an arterial oxygen saturation (SpO_2) $\geq 90\%$, prior to attempts at ETI, respectively. Initial mean SBP was 136 mmHg (SD 28.0) and mean post-ETI SBP 133 mmHg (SD 26.8, $p = 0.74$), and initial median SpO_2 was 98% (IQR 96-100%), and median post-ETI SpO_2 97% (IQR 95-100%, $p = 0.45$). The lowest median documented SpO_2 at any time in this group was 92% (IQR 87-95%), and lowest median ETCO₂ 32mmHg (IQR 28-35 mmHg). **Conclusions:** We describe the results of a successful prehospital ETI program performed by CCPs demonstrating optimized peri-intubation physiology in a cohort of major trauma and TBI patients. Further studies are needed to assess the functional outcome of such a program in this patient population.

61. VIDEO LARYNGOSCOPY IMPROVES INTUBATION SUCCESS IN CARDIAC ARREST AND ENABLES EXCELLENT CPR QUALITY

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Background: Endotracheal intubation (ETI) has been recognized as a common cause of interruptions in CPR during cardiac arrest. A pre-hospital trial of video laryngoscopy (VL) was initiated with the goals of improving out-of-hospital intubation outcomes. This study focused on overall success of VL in the subset of patients in cardiac arrest; analysis of the impact of VL on frequency and duration of associated interruptions in CPR was also performed. **Methods:** From January 2011 to June 2013, cases of adult, non-traumatic cardiac arrest in a suburban fire-based EMS system were evaluated for use of VL. Intubation confirmation in the field was accomplished with real-time waveform capnography, video capture of the ETI attempt, and confirmation from the receiving emergency department physician. VL recordings were reviewed to identify the overall ETI success, evidence of CPR during the intubation attempt, and interruptions in compressions. CPR analytics software was used to determine CPR fraction and duration of CPR interruptions when video evidence of compressions was not available. Data from the VL study were compared with historical direct laryngoscopy (DL) data. **Results:** 152 of 344 cardiac arrest incidents in the study period involved the use of video laryngoscopy and met inclusion study criteria. The overall success rate for VL was 148 out of 170 attempts (87.1%), while the overall success for the DL control group was 274/425 (64%). VL success was clinically and statistically different from the DL group ($p < 0.05$). EMS providers did not pause compressions for intubation attempts at any point in 68.6% of studied cases ($n = 105$). Of cases where CPR was interrupted ($n = 47$), the mean number of interruptions was 1 (range 1-3). The mean total duration of ETI-associated CPR interruptions ($n = 62$) was 45.1 s (CI 37.1-53.0). In cases where CPR analytics was available ($n = 34$), the mean CPR fraction was 87.5% (CI 84.8-90.2). **Conclusion:** The use of video laryngoscopy in cardiac arrest patients resulted in improved intubation success and enabled a reduced number and duration of interruptions in CPR compressions. Excellent CPR fraction was demonstrated for victims of cardiac arrest who were intubated by VL.

62. SUCCESS AND COMPLICATION RATES OF PREHOSPITAL PLACED CENTRAL VENOUS CATHETERS BY CRITICAL CARE PROVIDERS

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Background: Central line placement is occasionally performed during critical care transports. The objective of this study was to assess the safety, success, and complication rate of prehospital placed central venous catheters (CVCs) by critical care providers. **Methods:** A systematic chart review was performed of all patients presenting to our institution from November 2009 to April 2013 who had a CVC placed prehospital. In all cases, CVCs were placed by a trained critical care nurse or medic without the use of ultrasound. Providers were able to utilize all three approaches of CVC placement. Prehospital records were examined, cross-referenced with the hospital EMR, and reviewed for complications of CVC placement noted within the first 48 hours of admission. A complication was defined as either 1) positive blood culture resulted within 48 hours of

hospital care, 2) extraluminal placement of the CVC, or 3) traumatic placement of the CVC requiring surgical repair. **Results:** A total of 34 patients were identified in the 3.5 year study period as having attempted prehospital placed CVC. Two patients were excluded due to non-transport. Of the remaining 32, five patients required multiple attempts. Overall the success rate was 63.9% with a complication rate of 6.3%. Successful femoral CVCs placement was 70.8% overall. Successful subclavian placement was 50%. Two patients were identified with complications for a total complication rate of 6.3%. This rate is comparable to standard CVC complication rates. **Conclusions:** Prehospital critical care providers successfully placed 23 CVCs with a 6.3% complication rate. Based on these data, it appears that prehospital placed CVCs have a complication rate that is acceptable for emergent and critical situations and comparable to standard CVC complication rates. Further study is warranted.

63. HELICOPTER EMS TRANSPORTS FOR NON-TRAUMATIC AORTIC PATHOLOGIES

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Background: Nontraumatic aortic pathology constitutes a high-acuity critical care transport population. The goals of the current study were to 1) assess helicopter EMS (HEMS) transport frequency of patients with aortic dissection (AD), 2) determine the appropriateness of hemodynamic management of AD at referring hospitals, and 3) determine HEMS crews ability to achieve significant decrement in HR and SBP for AD patients during transport. **Methods:** A 36-month retrospective review of a national HEMS company database identified 278 consecutive HEMS-transported patients with nontraumatic aortic emergencies. Inappropriate hemodynamic management was defined a priori as patients with HR above 80 and SBP above 120 with no controlling medications, or administration of tachycardia-risking antihypertensives without HR control agents. Proportions were calculated with binomial exact confidence intervals (CIs). Central tendency was assessed by median with interquartile range (IQR) or mean with standard deviation (SD). Statistical significance for change in SBP and HR was defined as being present if the 95% CI for the mean change did not include the null value. **Results:** Overall, 278 eligible cases (73% male, mean age $68 \pm SD 13$) were transported with a median transport time of 73 minutes (IQR 60-92). These cases account for 0.27% of all transports. A primary diagnosis of AD was 91 (33%). A diagnosis of "dissecting abdominal AA", 44 (16%), demonstrates significant diagnostic uncertainty in referring hospital documentation. Inappropriate referring hospital hemodynamic management was identified in 46 cases (51%). Twenty nonbradycardic (HR ranging to 110) AD cases received vasodilators, 9 (45%) without HR control medications. Of the 56 (62%) AD patients with pretransport SBP > 120 , HEMS crews significantly decreased the SBP by a mean of 21 (95% CI 13 to 29). Those with pretransport HR > 80 , 38 (42%), HR was decreased by a mean of 9 (95% CI 1 to 17). **Conclusions:** Transport of acute aortic emergencies is common, constituting a minimal proportion of HEMS transports. These results suggest both diagnostic uncertainty and suboptimal hemodynamic management on the part of referring facilities, thus providing a focus for educational efforts. HEMS crews were able to achieve significant improvements in hemodynamics for AD patients.

64. ADVERSE EVENTS DURING LAND-BASED URGENT CRITICAL CARE

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Background: The risks associated with urgent land-based interfacility transport of critically-ill patients are not well known, and have important implications for patient safety, delivery of care, and policy development in a regionalized health-care system. We sought to determine the incidence of in-transit critical events and identify factors associated with these events. **Methods:** We conducted a retrospective cohort study using clinical and administrative data. We included all adults undergoing land-based critical care interfacility transport by a dedicated transport medicine agency between January 1, 2005, and December 31, 2010. The primary outcome was in-transit critical events, defined as death, major resuscitative procedure, hemodynamic deterioration, inadvertent extubation, or respiratory arrest. **Results:** We identified 6,076 patients undergoing urgent land-based critical care transport. In-transit critical events were observed in 6.1% of all transports, with a critical event occurring for every 11 hours of out-of-hospital transport time. New hypotension (4%) or the initiation of vasopressor medications (1.5%) were the most common critical events, with in-transit resuscitation procedures rarely performed (0.3%). No deaths occurred during transport. In multivariate analysis, mechanical ventilation (adjusted OR 1.7 [95%CI 1.3-2.2]), pre-transport hemodynamic instability (adjusted OR 3.4 [95%CI 2.5-4.5]), out-of-hospital duration (adjusted OR 3.2 per log-fold increase in time [95%CI 2.6-3.9]) and neurological diagnosis (adjusted OR 0.5 [95%CI 0.3-0.7] compared to medical patients) were independently associated with critical events. Overall success at airway management was high (85.7%), although the first attempt success rate of in-transit intubation attempts was lower than those attempts pre-transport (42.9% vs. 72.7%; $p = 0.19$). Advanced care paramedic crews had higher crude rates of in-transit critical events, driven primarily by new hypotension. These transports also had higher rates of hypotension pre-transport, but lower rates of vasopressor use pre-transport compared to other paramedic crews. **Conclusions:** Interfacility land-based critical care transport was safe: critical events occurred in about 1 in every 16 transports and no deaths occurred. Critical events were independently associated with pre-transport mechanical ventilation, pre-transport hemodynamic instability and transport duration, and were less frequent in patients with neurological diagnoses. Further examination of patient preparation pre-transport, particularly airway management and hemodynamic interventions, is required to inform interventions and policies to improve the safety of land-based critical care transport.

65. HELICOPTER EMERGENCY MEDICAL SERVICES (HEMS) UTILIZATION PATTERNS IN LAKE MEAD NATIONAL RECREATION AREA FROM 2008 TO 2011

Kellen Galster, Ryan Hodnick, Ross Berkeley, University of Nevada

Background: Lake Mead National Recreation Area (LMNRA) is the sixth most visited park of the National Park Service (NPS), protecting over 1.5 million acres of land. It is also the deadliest recreation area managed by the NPS. The objective was to determine whether patients transported by helicopter emergency medical service (HEMS) within LMNRA had greater vital sign abnormalities or scene response times compared with those transported by ground

emergency medical services (EMS). **Method:** Structured, retrospective review of all NPS EMS patient care records (PCR) in the LMNRA from 2008 to 2011. Two trained/monitored reviewers extracted data using a uniform data tool and explicit review process. Data were entered into a data base (MS Access). Chart abstraction accuracy was adjudicated by 100% review. We performed t-tests on continuous variables. Statistical significance was set at <0.05 . **Results:** A total of 954 PCRs were reviewed. 103 (10.9%) patients were transported by HEMS, with 526 (55.7%) transported by ground and 325 (33.4%) transport refusals. The majority of HEMS transports were male 65/103 (63%) with an average age of 40.8 (range 1-81). Traumatic injuries accounted for 63% (91% blunt and 9% penetrating) of the 103 HEMS transports, and comprised 54.3% (86.2% blunt and 14.9% penetrating) of the 526 EMS ground transports. Average time to scene by NPS EMS was 16.1 minutes for patients subsequently transported by HEMS, versus 14.1 minutes for ground transport ($p = 0.23$). The average time on scene by NPS EMS was 38.6 minutes for HEMS transport and 42.2 minutes for ground transport ($p = 0.05$). There were no statistically significant differences in vital signs of patients transported via HEMS as compared with ground EMS, with the exception of oxygen saturation and Glasgow Coma Scale (GCS). Oxygen saturation was 95.8% for HEMS transport versus 96.5% ground EMS ($p = 0.02$). The initial GCS for those transported via HEMS was 13.7 versus 14.5 via ground transport ($p = 0.01$). **Conclusion:** There was no difference in the scene response times for patients transported via HEMS and ground, and although a statistical difference was noted between pulse oximetry and GCS, neither was clinically significant. Additional study may help guide the development of a protocol for HEMS utilization by the NPS.

66. THE EVIDENCE-BASED PREHOSPITAL BLOOD PRESSURE TREATMENT THRESHOLD IN MAJOR TRAUMATIC BRAIN INJURY: "NORMOTENSION" MAY BE TOO LOW

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Background: The current nationally vetted EMS traumatic brain injury (TBI) guidelines utilize an SBP threshold of <90 mmHg for treating hypotension in patients 10 years or older. This is supported by a literature showing much higher mortality when cohorts of patients with SBP < 90 mmHg versus 90+ are compared. However, the historical use of this threshold was arbitrary. Hypothesis: In a large, multisystem evaluation of major TBI, no statistically-supportable SBP versus mortality cut-point will emerge from the data when evaluated a-priori without reference to any given definition for "hypotension." **Methods:** All moderate/severe TBI cases (CDC BARELL Matrix Type-1) in the Excellence in Prehospital Injury Care (EPIC) Study cohort of the Arizona State Trauma Registry (NIH/NINDS: 1R01NS071049; ClinicalTrials.gov-#NCT01339702) from 1/1/08 to 12/31/11 were evaluated [exclusions: age < 10 , transfers, death before ED arrival, missing EMS SBP (3.0%)]. The subset of patients with SBP between 10 and 140 mmHg (study population) were assessed using fractional polynomials and logistic regression-LR to determine the relationship between SBP and the odds of death. **Results:** 4,969 patients met inclusion cri-

teria. SBP was linearly associated with the log odds (logit) of death and no transformation improved the model fit compared to the untransformed (linear) values of SBP. LR showed that each five-point increase of SBP decreased the odds of death by 13.8% (OR = 0.862, 95% CI: 0.842-0.883) across the range of SBP = 10-140. After controlling for GCS, O₂ saturation, AIS, ISS, AIS-Head, prehospital airway management, age, sex, payor) this linear relationship held up with an aOR for death of 0.942 (0.911-0.974) for each 5-mmHg increase in SBP (e.g., a patient with SBP = 110 has an aOR for death of 0.880 compared to a patient with SBP = 100, and so on throughout the range). **Conclusion:** We found a linear relationship between SBP and severity-adjusted risk of mortality across an exceptionally wide range. Thus, for the injured brain, "functional hypotension" may not be as low as current guidelines suggest. The fact that the adjusted odds of death increases as much for an SBP of 110 mmHg versus 100 as it does for 100 versus 90 suggests that the optimal resuscitation target may be much higher than 90 mmHg. Specific trials comparing various treatment thresholds are needed.

67. IS FASTER BETTER? DOES THE TIME SAVED WITH HELICOPTER EMERGENCY MEDICAL SERVICES (HEMS) TRANSPORT IMPACT CARE PROVIDED AT A LEVEL 1 TRAUMA CENTER?

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Background: Helicopter emergency medical services (HEMS) are faster than ground ambulance when transporting certain patients to a regional trauma center in southeastern Wisconsin; faster access should translate to faster care. To assess the impact of mode of transportation on access and care to a regional trauma center, we propose a theoretical race between actual HEMS flight time with estimated ground ambulance transport time; in order to assess the clinical implications of any potential minutes gained, we will investigate what care can be rendered during that time savings. **Methods:** This study is a retrospective chart review of all helicopter scene transports from 1/1/2009 through 6/30/2009 to one regional trauma center. This study received IRB approval. Descriptive statistics were used to quantify the time difference between helicopter transport and ambulance transport both with and without lights and sirens. We also used descriptive statistics to quantify the number of assessments or interventions performed on each patient within the estimated time differences. **Results:** Forty-nine patients were included in final analyses with the average helicopter transport time of 15.5 (SD 6) minutes. The average estimated ground transport time with lights and sirens was 26.5 (SD 12.4) minutes (helicopter was 91.9% faster), and without lights and sirens was 41.7 (SD 19.5) minutes (helicopter was 100% faster). The average difference between ground and helicopter transport was 10.3 (SD 8.6) minutes with lights and sirens and 24.9 (SD 15.7) minutes without lights and sirens. Of the 49 patients transported by HEMS, 81 to 100% of patients received a completed primary survey, 8.1-24.5% of patients received a life- or limb-saving intervention, 53-91% of patients received ATLS adjunct studies, 6-16% of patients had an imaging diagnosis, and 0-2% had subspecialist evaluation faster when compared to estimated ground response with light and sirens and without respectively. **Conclusion:** In this theoretical race, HEMS transport was faster than ground transport in the majority of cases. This model predicts that this time savings translates into earlier ATLS assessment and interventions.

Further work is needed to verify this benefit and demonstrate its impact on patient outcomes.

68. OPERATIONALIZING A CONSENSUS-BASED GOLD STANDARD DEFINITION OF TRAUMA CENTER NEED

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Background: Research on field triage of injured patients is limited by the lack of a functional gold standard (GS) for defining trauma center need. Injury severity score (ISS) is one of the most commonly used measures for determining trauma center need, but is a proxy for resource use and has never been validated. A multidisciplinary team recently developed a treatment-based GS definition of trauma center need. **Objective:** To determine if the treatment-based GS could be obtained by medical record review and to compare patients identified as needing a trauma center by the treatment-based GS versus ISS. **Methods:** A sub-analysis of data collected during a 3-year prospective cohort study of 4,528 adult trauma patients transported by EMS to a trauma center was conducted. These data included procedure and ICD-9 codes, treatment times, and other hospital and EMS data. The treatment-based GS was operationalized, and for each case it was determined if the patient met the GS. ISS was calculated based on coder assigned ICD-9 codes. **Results:** The treatment-based GS was assigned to 4,471 (98.7%) cases. Missing time data prevented the GS from being assigned in the remaining 57 cases. ISS was assigned to 4,506 (99.5%) cases. Based on an ISS > 15, 8.9% of cases needed a trauma center. Of those, only 48.2% met the treatment-based GS. Almost all patients that did not meet the GS, but had an ISS > 15 were diagnosed with chest (rib fractures/pneumothorax), closed head, vertebral, and extremity injuries. There were 4,053 cases with an ISS < 15. 5.0% of those with an ISS < 15 met the treatment-based GS with the majority having a time sensitive surgery (139/203 cases) or blood transfusion (60/203 cases). The kappa coefficient of agreement for ISS and treatment-based GS was 0.43. **Conclusions:** It is feasible to use a treatment-based GS for trauma center need when conducting field triage research. Use of a treatment-based GS changes the number and types of patients identified as needing a trauma center compared to ISS. Researchers should consider using a treatment-based GS and efforts should be made to achieve national consensus on treatment-based parameters that indicate trauma center need.

69. PREHOSPITAL GLUCOSE AS A PREDICTOR OF HOSPITAL OUTCOMES AFTER ACUTE TRAUMATIC BRAIN INJURY IN PATIENTS OLDER THAN 55 YEARS

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Background: The objective of the study was to determine if prehospital glucose predicts hospital outcomes in the setting of traumatic brain injury (TBI) in patients older than 55 years. **Methods:** This study consisted of all patients older than 55 years, and transported via EMS to the emergency department of a level 1 trauma center with a TBI during a period of 30 months. Medical records of patients were abstracted for following information: mechanism of injury, Glasgow Coma Scale (GCS) scores by EM, glucose measurement by EMS, and hospital outcomes such as abnormal CT scan findings, hospital admission, ICU admission, in-

hospital death, etc. An abnormal head CT was defined as the presence of fracture, bleed, or any shift/herniation based on radiology reports. Statistical analyses were performed using JMP 10.0. This study was approved by our institutional review board. **Results:** A total of 872 patients presented to ED with a TBI during study time period. Out of those, 629 (72.1%) arrived ground EMS, 101 (11.6%) by air EMS, and 142 by car/walk-in. EMS GCS scores were available for 455 of 730 (62.3%) patients who arrived via EMS. TBI severity based on EMS GCS score were 362 (79.6%) mild, 32 (7%) moderate, and 61 (13.4%) severe. Glucose values (mg/dL) measured by EMS were available for 185 (median = 122, IQR = 103-147). Glucose levels were divided in two groups: = 140 mg/dL and >140 mg/dL. Chi-square analyses revealed that the group with glucose >140 was significantly associated with the risk of having an abnormal head CT (p = 0.01), ICU admission (p = 0.02), and in-hospital death (p = 0.008), but not hospital admission (p = 0.39). Severe TBI based on EMS GCS scores, increasing age, and male sex were also significantly associated with all above described outcomes. Logistic regression analyses showed that higher EMS glucose (>140) was significant predictor for CT scan abnormality (p = 0.02, OR = 2.4, CI = 1.15-5.28) and in-hospital death (p = 0.005, OR = 9.9, CI = 2.3-68.6), when controlling for EMS TBI severity, age, and sex. EMS glucose also had a strong trend toward ICU admission (p = 0.0503, OR = 2.05, CI = 0.998-4.25). **Conclusion:** In an emergency department cohort of patients with traumatic brain injury, EMS glucose level can be a useful tool in predicting hospital outcomes, and may help in triage of head patients in a busy emergency department.

70. COMPLIANCE OF A BYPASSING HOSPITAL TRAUMA PROTOCOL USING THE FIELD TRIAGE DECISION SCHEME BETWEEN METROPOLITAN VERSUS NON-METROPOLITAN EMERGENCY MEDICAL SERVICES

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Background: A trauma protocol for transport bypassing hospital for severe trauma patients was developed and implemented in Korea in 2012 using the field triage decision scheme of the Centers for Disease Control and Prevention of the US. Emergency medical services (EMS) and hospital resources are significantly different in metropolitan versus non-metropolitan areas, but the protocol does not include the difference. The study aims to evaluate the compliance of the protocol in severe trauma between metropolitan versus non-metropolitan area. **Methods:** Severe trauma patients were identified by the new protocol and collected from a trauma registry and EMS run sheet in one metropolitan (8 counties and 53 ambulances) with 2.5 million population and one non-metropolitan province (17 counties and 136 ambulances) with 2.7 million population from October 2012 (one month). The same protocol was implemented by national fire department which provides single tiered intermediate EMS service in whole area. Data variables included demographic findings on EMS agency, age, and gender, clinical information on vital signs and mental status, injury related variables like mechanisms, geographic information on place of the event, and distance to nearest, bypassed, and destination hospitals. Exposures are metropolitan versus non-metropolitan ambulances defined. Study end point was appropriate direct transport (A-DT), appropriate bypassing transport (A-BT), inappropriate non-bypassing transport

(I-NT), and inappropriate bypassing transport (I-BT). The protocol violation with number of I-NT and I-BT divided by number of eligible patient were compared between metropolitan and non-metropolitan ambulances. **Results:** Of the 863 patients with severe trauma were identified by the protocol (male 66.6%, mean age 48.7 ± 38.3 years), No statistical difference in demographics and clinical parameters except injury mechanism and distance to destination hospital. The A-DT, A-BT, I-NT and I-BT were 27.4%, 18.5%, 20.2%, and 33.4% respectively. I-BT rate was significantly lower in metropolitan than non-metropolitan (8.2% versus 30.6%, p = 0.001), while I-BT rate was significantly higher in metropolitan than non-metropolitan (46.2% versus 23.3%, p = 0.001), respectively. **Conclusions:** Protocol violation rates were significantly different in non-bypassing and inappropriate 4. bypassing to hospital between metropolitan versus non-metropolitan ambulances when using the bypassing hospital trauma protocol. To develop and implement the trauma protocol, geographical compliance should be considered.

71. EVALUATION OF SIMPLIFIED PREHOSPITAL TRAUMA TRIAGE CRITERIA

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Background: Field triage accuracy regarding trauma is essential to improve patient outcomes and allocate resources. Centers for Disease Control and Prevention (CDC) guidelines for trauma are complex with high over-triage rates. This pilot study was undertaken to assess the ability of a simplified set of prehospital trauma triage criteria to predict the need for level 1 resources and plan for a prospective evaluation. **Methods:** This is a retrospective review of 1,025 patients triaged by an urban emergency medical services (EMS) system that provides 9-1-1 services for 200,000 people. All patients meeting trauma triage criteria are transported to the regional level 1 trauma center where the trauma team is activated. The triage criteria are 1) GCS of 12 or less, 2) SBP < 100, 3) airway compromise, 4) penetrating injury to head, neck, or torso, 5) pulseless extremity or amputation proximal to hand or foot, and 6) new onset paralysis. Patients who met these criteria at other local hospitals are transferred to the trauma center per a local trauma system agreement by the same urban EMS system. The need for transfusion < 24 hours, surgery < 6 hours, or ICU admission were the end points used to determine the patient need for level 1 resources. Discharged patients were not included in the study. **Results:** Of the 1,025 patients transported by EMS to the trauma center, 305 were admitted and 17 died in the ED. 152 met the study triage criteria for trauma team activation. Of those 152 patients 113 (74.3%) met one or more of the study endpoints for an over triage rate of 25.7%. 170 patients did not meet the criteria; 4 (2.4%) of these patients required trauma team activation after arrival in the ED. 69 (40.6%) of the patients not meeting the triage criteria met one or more of the endpoints. **Conclusion:** The simplified criteria used in this study have a favorable over-triage rate when compared with the CDC guidelines. They also reliably predict the need for trauma team activation; however, determination of their true under-triage rate will require revision of the endpoints.

72. DOES EMERGENT EMERGENCY MEDICAL SERVICES TRANSPORT MODE PREDICT NEED FOR TIME CRITICAL HOSPITAL INTERVENTION IN TRAUMA PATIENTS?

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Background: Emergency medical services (EMS) emergent transport using lights and siren accounted for 58% of national ambulance collisions between 1990 and 2009, posing a major public health threat to EMS professionals and patients. Further, several studies have demonstrated time saved using emergent transport mode is minimal and commonly without clinical benefit. Our study's objective was to measure the association of transport modes selected by an urban EMS agency with the likelihood of receiving a time-critical hospital intervention (TCHI) within 60 minutes of hospital arrival in adult trauma patients. **Methods:** We retrospectively reviewed EMS patient care reports and trauma registry data for trauma patients consecutively transported from the field by a single advanced life support EMS agency to a level I trauma center between 7/1/10 and 6/30/12. We considered transports that initiated lights and siren at anytime as emergent. Our outcome of interest, receiving a TCHI, was defined as administering at least one of 36 preselected life-, limb-, or eye-saving procedures within 60 minutes of arrival. We measured the predictive ability of emergent transport by reporting sensitivity, specificity, positive predictive values (PPV), and negative predictive values (NPV) with 95% confidence intervals (CI). **Results:** Of 809 patients transported and admitted during the study period, 66 were excluded due to missing data, leaving 743 patients eligible for the final analysis. Of the 165 patients (20.7%) transported emergently, 50 (31.8%) received a TCHI. The sensitivity and specificity of transport mode in predicting need for a TCHI was 73.5% (95% CI 61.21–83.16) and 83.0% (95% CI 79.86–85.68), respectively. The PPV was 30.3% (95% CI 23.53–38.01); NPV was 96.9% (95% CI 95.03–98.09). **Conclusions:** Emergent transport resulted in a low positive predictive value (30.3%) when predicting the need for TCHI in adult trauma patients, suggesting substantial unnecessary emergent transport. Further research is needed to identify clinical factors closely associated with the need for a TCHI and subsequent protocol development to guide the use of emergent transport in trauma patients.

73. ON THE SPOT: IMPLEMENTATION OF A TRAUMA TEAM ACTIVATION TIMEOUT IN A LEVEL 1 TRAUMA CENTER

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Background: Effective provider communication during care transitions is a key component of patient care. Handoffs between paramedics and emergency department staff during trauma cases can be particularly chaotic. This study examined provider perceptions of a new communication tool used during transfer of trauma patient care at an urban level I trauma center. **Methods:** The local Regional Trauma Advisory Council led the design and implementation of a new communication process called a Trauma Team Activation Timeout (TTA Timeout). Prior to implementation of this pilot project, over 800 EMS providers viewed a YouTube video introducing the specifics of the protocol, including a mock scenario. The protocol required paramedics to verbalize "TTA Timeout" when entering the trauma bay at a single, urban level I trauma center. Hospital staff was expected to remain quiet and attentive during the paramedic report, which was delivered in the MIST format (mechanism, injuries, symptoms, and treatments). Immediately following transfer of care, the lead paramedic and the trauma team leader completed a 7-item sur-

vey assessing their experience. Responses to survey questions were compared between EMS providers and trauma team leaders using rank sum correlation. **Results:** Data were collected from 51 paramedics (17 EMS agencies) and 45 team leaders between March 1 and April 30, 2013. Paramedics believed the benefit of the TTA timeout was higher to the EMS provider (100% vs. 77%, $p < 0.001$), patient (100% vs. 75%, $p < 0.001$), and team leader (100% vs. 80%, $p < 0.001$) than the trauma team leader's evaluation. Paramedics perceived the TTA timeout to result in higher effectiveness in the transfer of the patient than trauma team leaders (Spearman's rho = -0.2; $p = 0.04$). Paramedics and trauma team leaders did not differ in their assessment of the following components of the timeout: 1) announcing "Time Out", 2) time limit for medic, 3) complete silence during medic report, 4) questions only coming from team lead, and 5) dispatch information prior to EMS arrival. **Conclusion:** Paramedics report greater benefit of the TTA timeout process than the in-hospital trauma team leaders. In-hospital personnel may require more education about the importance of the EMS report with the critically injured patient.

74. AGE BIAS IN HELICOPTER EMERGENCY MEDICAL SERVICE TRAUMA TRIAGE

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Background: Due to the decreased physical reserves and increased comorbid conditions of elderly trauma patients, the American College of Surgeons recommends prompt, aggressive resuscitation to improve survival. Previous trauma system studies have demonstrated a bias toward undertriaging elderly trauma patients. To date, no studies have focused on age bias in helicopter emergency medical service (HEMS) trauma triage. The aim of this study was to determine whether there is an age bias in the triage of patients in the HEMS environment. **Methods:** A cross-sectional study of registry data from two system trauma centers and the associated HEMS transport records was conducted. Inclusion criteria comprised trauma transports of patients ≥ 15 years old (near-drowning and burns were excluded). The injury severity score (ISS) and hospital length of stay (LOS) were recorded for interfacility and scene transports. Overtriage was defined as (1) alive with ISS < 12 and (2) alive with LOS ≤ 24 hours. Multiple logistic regression models were used to determine the odds of ISS and LOS overtriage by patient age, adjusting for destination and origin. The model for LOS overtriage was additionally adjusted for ISS. **Results:** Of 2,528 patients, 1,035 (40.9%) were overtriaged by ISS and 397 (15.7%) were overtriaged by LOS. The overtriage rates were significantly lower in patients ≥ 65 vs. < 65 years old (30.0% vs. 42.9%, $p < 0.001$ for ISS; 5.4% vs. 17.6%, $p < 0.001$ for LOS). On multivariable analysis of ISS and LOS overtriage, older patients remained significantly less likely to be overtriaged (odds ratio 0.56, 95% confidence interval 0.44–0.71, for patients ≥ 65 years old; odds ratio 0.33, 95% confidence interval 0.20–0.54, for patients < 65 years old). Within the overtriage categories, there was no statistically significant difference in ISS by age to account for the decrease in overtriage in elderly patients. **Conclusions:** It was assumed that rates of overtriage would be higher in the elderly trauma population as health-care providers would be more apt to render prompt, aggressive resuscitation. Conversely, the data demonstrated significantly less probability of overtriaging elderly patients, which corresponds to undertriaging reported in previous trauma system studies.

75. NEEDLE THORACOSTOMY IN THE PREHOSPITAL SETTING FOR TRAUMA PATIENTS WITH PROLONGED TRANSPORT TIMES: A RETROSPECTIVE MATCHED CASE-CONTROL STUDY

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Background: The use of prehospital needle thoracostomy (NT) is controversial. Some studies support its use, however, concerns still exist regarding misplacement, inappropriate patient selection and iatrogenic injury. The purpose of this study is to compare patients who underwent NT with prolonged transport (PT) versus short transport (ST) times and to evaluate differences in outcomes and complications. **Methods:** This was a retrospective matched case-control study of all trauma patients cared for by a four county emergency medical service (EMS) agency between 4/1/2007 and 4/1/2013. This agency serves an urban, rural and wilderness catchment area of greater than 1.6 million people. A prehospital database was queried for all patients in whom NT was performed, identifying 169 patients. When these calls were limited to those with PT (> 60 minutes), the search was narrowed to 32 cases. A matched control group, based on age and gender, with ST times, was then created as a comparison. Data collected from prehospital and hospital records included demographics, mechanism of injury, call status, time on scene (TOS), total prehospital care time (TPC), transport miles to the hospital (TM), reported complications, and final outcome. Information was manually abstracted by investigators then entered into Excel (Microsoft) and imported into SPSS, version 20.0.0 (IBM) where appropriate statistical tests were calculated. **Results:** As expected, the mean TPC time was significantly greater in the PT group when compared to control ($p = 0.001$) as was the mean TM ($p = 0.0001$). Mean TOS was also longer in the PT group ($p = 0.0001$). Patients with PT were more likely to have sustained blunt trauma (91 versus 69%, $p = 0.05$), and were more likely to have vital signs on initial assessment (69 versus 34%, $p = 0.001$); however, their survival to hospital discharge was not significantly different (34 versus 25%, $p = 0.54$). No complications for NT were reported in either group. **Conclusions:** There was no significant difference in survival rates in patients who underwent NT when comparing PT to ST times. No complications of NT were reported. Of interest, patients with PT also had prolonged TOS, suggesting increased complexity of care for patients who sustain injuries far from definitive care.

76. HOW SUSPECTED HEAD INJURY, ANTICOAGULANTS, AND PLATELET INHIBITORS INFLUENCE EMS PROVIDERS' TRAUMA TRIAGE DECISIONS

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Background: This study aimed to determine the process used by EMS providers when making trauma triage decisions for older adult patients who have a suspected traumatic brain injury (TBI) and how use of anticoagulants and/or platelet inhibitors influences these decisions. **Methods:** Focus groups were conducted with ALS and BLS providers, recruited from urban/suburban and rural EMS agencies. A semi-structured guide facilitated discussion on four key topics: 1) how EMS providers assess for TBI; 2) how EMS providers assess for current medications; 3) how medications

affect trauma triage decisions; and 4) how suspected TBI affects trauma triage decisions. All focus groups were transcribed and analyzed using content analysis by a multidisciplinary team. Transcripts were reviewed and coded by multiple reviewers, and areas of coding disagreement were discussed until consensus was achieved. Codes were then grouped into overarching themes and domains. **Results:** Five focus groups included a total of 23 participants. Six themes emerged under two overarching domains: 1) patient assessment and 2) trauma triage decisions. Within the six themes, EMS providers agreed their overall assessment is initially driven by a dichotomous gestalt impression (bad vs. not so bad) and followed by a more detailed patient assessment of history, medication use, physical findings, mental status, etc. EMS providers reported formal tools for assessment of TBI, such as Glasgow Coma Scale, are not consistently or reliably used in the prehospital setting. Respondents did acknowledge specifically asking about anticoagulants/platelet inhibitors when caring for injured older adults. Suspected head injury and confirmed use of anticoagulant medication influenced choice of receiving hospital depending on local resource availability, including availability of diagnostic equipment and highly trained medical staff. **Conclusion:** This qualitative study identified key issues related to trauma triage of older patients with suspected TBI who take anticoagulants and/or platelet inhibitors. EMS providers reported using dichotomous gestalt thought processes rather than more complex scales or tools to inform both urgency of transport and their final selection of a receiving hospital. These findings should be confirmed in independent samples of EMS providers as well as through quantitative methods.

77. NALOXONE IS OVERUSED IN GERIATRIC PATIENTS IN THE PREHOSPITAL SETTING

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Background: Many clinicians would argue that the only appropriate prehospital use of naloxone is to improve ventilation, and prehospital providers should not be trying to make a diagnosis. Anecdotally, naloxone is often used in geriatric patients to assist in the diagnosis of those with altered mental status. We sought to determine what percentage of naloxone administrations in geriatric patients is for hypoventilation and altered mental status and how often it has a positive outcome. Setting: A large, suburban, two-tiered EMS system with approximately 25,000 advanced life support (ALS) requests per year. Design: Retrospective cohort study. Population: Consecutive patients age 60 and overtreated prehospitally with naloxone over a 60-month period. Vital signs on initial ALS evaluation and on arrival in at the emergency department (ED) were recorded. A priori, hypoventilation was defined as an initial respiratory rate (RR) <10 or a pulse oximetry <92%. A positive response to naloxone was defined as an increase of 4 or more breaths per minute or final pulse oximetry over 95% in a patient who was not intubated. Altered mental status (AMS) was defined as having a Glasgow Coma Score (GCS) of less than 14. Percentages and 95% confidence intervals (CI) were calculated. **Results:** Of 105,183 ALS requests, 230 (0.2%) were for patients 60 years or older who were given naloxone. 92% (CI: 88, 95) had a dispatch category other than Ingestion or Overdose. 84% (CI: 78, 89) had an initial GCS less than 14. Only 22% (CI: 16, 27) of patients were hypoventilating at the time of naloxone administration. All of these hypoventilating patients also had an AMS. Of the hypoventilating pa-

tients with AMS, 16% (CI: 6, 26) had a positive response. Of all the patients age 60 or over who were given naloxone, only 4% (CI: 1,6) had a positive response. **Conclusion:** More than 75% of geriatric patients treated with naloxone are not hypoventilating, suggesting that it is being administered for other reasons. When used in patients with AMS and hypoventilation, one-sixth improve. Overall, only 4% of patients age 60 years and older given naloxone seem to improve, suggesting it is being overused.

78. PREHOSPITAL END-TIDAL CARBON DIOXIDE IS ASSOCIATED WITH METABOLIC ACIDOSIS AND PREDICTS IN-HOSPITAL MORTALITY

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Background: To determine the ability of prehospital end-tidal carbon dioxide (ETCO₂) to predict in-hospital mortality compared to traditional vital signs, and to examine the association of ETCO₂ with metabolic acidosis. **Methods:** We conducted a retrospective cohort study among patients transported by emergency medical services (EMS) during a 29-month period. Included patients had ETCO₂ recorded in addition to initial vital signs. Records were linked by manual archiving of EMS and hospital data. The main outcome was death at any point during hospitalization. Secondary outcomes included metabolic or lactic acidosis in the emergency department. **Results:** There were 1,328 out-of-hospital records reviewed. Hospital discharge data, ETCO₂, and all six prehospital vital signs were available in 1,088 patients. Of the 1,088 patients, 132 (12%) were trauma-related, 776 (71%) were admitted, 40 (4%) did not survive, and 114 (11%) were admitted to intensive care. Low ETCO₂ levels were the strongest predictor of mortality in the overall group, with an area under the ROC Curve (AUC) of 0.76 (0.66-0.85), as well as when patients in prehospital cardiac arrest were removed from the analysis, with an AUC of 0.77 (0.67-0.87). The significant adjusted odds ratios of abnormal vitals for mortality included ETCO₂ (1.11, 95% CI 1.06-1.15), systolic blood pressure (1.03, 95% CI 1.01-1.05), pulse oximetry (1.06, 95% CI 1.04-1.09), and shock index (4.9, 95% CI 1.0-24.4). Defining abnormal ETCO₂ as < 31 mmHg or > 41 mmHg, the sensitivity for predicting mortality was 93% (95% CI 79-98%), the specificity was 44% (95% CI 41-48%), and the negative predictive value was 99% (95% CI 92-100%). In patients who had blood drawn, there were significant associations between ETCO₂ and serum bicarbonate levels (r = 0.429, P < 0.001), anion gap (r = -0.216, P < 0.001), and lactate (r = -0.376, P < 0.001). **Conclusion:** Of all the vital signs recorded in the out-of-hospital setting ETCO₂ was the most predictive and consistent for mortality, which may be related to an association with metabolic acidosis. This has implications for improving out-of-hospital triage and could help EMS personnel direct patients to the appropriate destination of care.

79. AN EMS SEPSIS ALERT PROTOCOL REDUCES TIME TO ANTIBIOTICS IN PATIENTS PRESENTING TO THE ED WITH SEVERE SEPSIS OR SEPTIC SHOCK

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Background: The goal of the project was to determine if an EMS "sepsis alert" (ESA) protocol with point-of-care lactate measurement decreases time of arrival (TOA) to administration of broad-spectrum antibiotics, length of stay (LOS) measures and mortality. **Method-**

ods: Before-and-after intervention study of the impacts of an ESA protocol on patients with severe sepsis/septic shock transported to an academic, tertiary care hospital by a county-based municipal paramedic service. Criteria for ESA protocol group were 1) Presence of 2 or more systemic inflammatory response syndrome (SIRS) criteria (HR > 90, RR > 20, T > 38 or < 36) plus paramedic clinical suspicion for infection, 2) prehospital venous lactate measurement = 4 mmol/dL, and 3) hospital notification of an ESA. Additional hospital response guidelines to an ESA were developed with the protocol to expedite care. Standardized, retrospective chart review was performed to collect data. **Results:** 91 patients were enrolled in the "before" (pre-ESA) group and 84 in the "after" group, with 53 (63%) of these patients having an ESA activation (ESA group). There were no significant differences between the pre-ESA and ESA groups with respect to age (69.8 vs. 71.3 years old), initial ED lactate level (4.7 vs. 4.8 mmol/dL) and ED APACHE II (22 vs. 22). Mean TOA to appropriate antibiotics was reduced by 48% in the ESA group vs. the pre-ESA group (74 ± 52 min vs. 141 ± 97 min, p = 0.008). There were no significant differences in ED, hospital or ICU LOS measures between groups. Mortality in ESA and pre-ESA groups were 34.6% vs. 35.5%, p = 0.92. Dichotomized analysis of mortality with respect to the primary goal of achieving antibiotic administration within 60 minutes showed that 49% vs. 14% of patients met this target in the ESA and pre-ESA groups, respectively (p < 0.001). Mortality in patients receiving antibiotics <60 minutes was 20.5% vs. 41% if = 60 minutes (p = 0.023). **Conclusions:** An ESA reduces TOA to appropriate antibiotics in patients with severe sepsis/septic shock. The proportion of patients in the ESA group that received antibiotics within 60 minutes of arrival was 3-fold that of the pre-ESA group. EMS systems can have a significant impact on the care of patients with sepsis and meeting critical benchmarks.

80. MIDAZOLAM IS SUPERIOR TO DIAZEPAM FOR TREATMENT OF PREHOSPITAL SEIZURES

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Background: Diazepam and midazolam are commonly used by paramedics to treat seizures. We used a period of drug scarcity as an opportunity to compare their effectiveness in treating prehospital seizures. **Methods:** A retrospective chart review of a single large commercial agency during a 29-month period, which included alternating shortages of both medications. Ambulances were stocked with either diazepam or midazolam based on availability of the drugs. Adult patients who received at least one parenteral dose of diazepam or midazolam for treatment of seizures were included. The regional prehospital protocol recommended 5 mg intravenous (IV) diazepam, 5 mg intramuscular (IM) diazepam, 5 mg IM midazolam, or 2.5 mg IV midazolam. Medication effectiveness was compared with respect to the primary end point: cessation of seizure without repeat seizure during the prehospital encounter. **Results:** A total of 440 study subjects received 577 administrations of diazepam or midazolam and met the study criteria. The subjects were 52% male, with a mean age of 48 (range 18-94) years. A total of 237 subjects received 329 doses of diazepam, 64 (27%) were treated with first dose IM. A total of 203 subjects received 248 doses of midazolam, 71 (35%) were treated with first dose IM. Seizure stopped and did not recur in 25% of subjects after a first dose of IM diazepam and 69% of subjects after a first dose

of IM midazolam ($p < 0.0001$). Diazepam and midazolam exhibited similar first dose success for IV administration (58% vs. 62%; $p = 0.294$). Age, gender, seizure history, hypoglycemia, the presence of trauma, time to first administration, prehospital contact time and frequency of IM administration were all similar between groups. **Conclusion:** For IM administration, midazolam demonstrated superior first-dose seizure suppression. This study demonstrates how periods of drug scarcity can be utilized to study prehospital medication effectiveness.

81. PARAMEDIC RECOGNITION AND MANAGEMENT OF ANAPHYLAXIS IN THE PREHOSPITAL SETTING

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Background: No published report has evaluated paramedic management of anaphylaxis in Canada. Since most cases of anaphylaxis are out-of-hospital, and delay in epinephrine administration increases mortality, immediate paramedic recognition and response are paramount. The primary objective was to determine the proportion of cases that met the definition of anaphylaxis and were administered epinephrine by paramedics. The secondary objective was to determine the proportion of anaphylaxis cases administered epinephrine within 10 minutes of patient contact. **Method:** This was a retrospective observational study of patients with anaphylaxis managed by primary or advanced care paramedics in 6 emergency medical service areas in Ontario, from January 1, 2012 to December 31, 2012. All ambulance call records (ACR) coded as local allergic reaction (code 84) or anaphylaxis (code 85) were reviewed by the authors, to determine if the patients met the definition for anaphylaxis as outlined by international guidelines. The timing of all medications administered and procedures completed were then abstracted into a database. **Results:** One hundred and seventeen ACRs were reviewed in total. All cases coded as anaphylaxis 68/68 (100%) were correctly identified. However, 26/49 (53%) of cases were incorrectly coded as local allergic reaction when they met anaphylaxis criteria. Thus, 68/94 (72%) of all patients meeting anaphylaxis criteria were correctly identified. Epinephrine was administered in 47/82 (57%) of anaphylaxis cases. 36/47 (77%) of these received epinephrine in 10 minutes or less, with a mean of 7.63 minutes (95% CI: 6.47 - 8.98). **Conclusion:** There appear to be gaps in the recognition of anaphylaxis by paramedics in Ontario. Similarly, gaps exist in the life-saving use of epinephrine for anaphylaxis, since it was administered in just over half of cases. However, when epinephrine was administered it was done so in a timely manner for most patients. As part of a quality improvement initiative, this data will be used to evaluate and enhance the training and medical directives utilized by paramedics to improve their recognition and management of patients with anaphylaxis.

82. PREHOSPITAL KETAMINE DOES NOT PROLONG ON-SCENE TIME COMPARED TO HALOPERIDOL WHEN USED FOR CHEMICAL RESTRAINT

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Background: Agitated and violent patients may present a danger to themselves and emergency medical services (EMS) providers. Behavioral emergencies may also distract from diagnosing and treating critical medical and traumatic pathologies. In order to improve pa-

tient and provider safety as well as allow EMS providers to safely conduct an accurate and thorough medical assessment, severely agitated patients frequently require chemical restraints. Antipsychotics such as haloperidol, often in combination with benzodiazepines, have long been employed for chemical restraint in many EMS services. Recently, ketamine has been added as an option. Minimizing on-scene time to facilitate rapid transport to a receiving emergency department (ED) is a key quality metric in EMS. We aimed to evaluate whether the use of ketamine for chemical restraint was associated with an increased on-scene time compared to haloperidol. **Methods:** Following IRB approval, the electronic prehospital care report (E-PCR) database from an urban, fire-based, single-tier EMS system over a 35-month period was retrospectively reviewed. The E-PCR database was queried for "ketamine" and separately for "haloperidol" under the medication administered data field. Patient demographic information (age, gender, chief complaint), on-scene time (time from patient contact to scene departure), and co-administration of haloperidol with a benzodiazepine or diphenhydramine were abstracted. Patient demographic information was compared between groups using the Student t-test (age) and chi-squared (gender; chief complaint). On-scene time was compared using an unadjusted Student t-test. **Results:** A total of 99 cases were identified during the study period (haloperidol = 59; ketamine = 40). Benzodiazepines were co-administered with haloperidol in 47/59 (80%) cases while ketamine was given as monotherapy in all cases. There were no differences between haloperidol and ketamine treatment groups in terms of age (37.6 ± 17.8 vs. 36.3 ± 12.9 ; $p = 0.70$), % male (59.3% vs. 70.0%; $p = 0.28$) or % of patients with psychiatric chief complaint (44.1% vs. 55.0%; $p = 0.29$). There was no statistical difference in on-scene time for patients receiving haloperidol compared to ketamine (18.2 ± 9.3 vs. 15.5 ± 10.4 ; $p = 0.19$). **Conclusions:** In this urban EMS system, the use of prehospital ketamine for chemical restraint was not associated with an increased on-scene time compared to haloperidol.

83. PREHOSPITAL KETAMINE FOR CHEMICAL RESTRAINT: ADMINISTERED DOSE VERSUS INTUBATION RATE

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Background: Ketamine has become increasingly popular for prehospital chemical restraint due to its favorable side effect profile, rapid onset, wide therapeutic window, and multiple routes of administration. Clinically significant adverse events include hypersalivation, laryngospasm, emergence reactions, and respiratory depression. To better understand the risk-benefit ratio and appropriate dosing of ketamine for prehospital chemical restraint, we report a series of 49 patients who received prehospital ketamine. **Methods:** After IRB approval, prehospital care reports and corresponding emergency department records were reviewed from a large urban fire-based EMS service over a 2-year period. All patients receiving prehospital ketamine by EMS were included. Patients were excluded if dose or weight was not documented in any patient record, if ketamine was given for reasons other than chemical restraint, or if transport was to a facility other than a single regional trauma center. Data were analyzed using unadjusted Student t-tests to identify any statistically significant differences in the dosing amount when categorized by need for additional sedation,

intubation, presence of emergence reaction, laryngospasm, and need for hospital admission to a medical unit. **Results:** 70 patient encounters were identified. 21 patients were excluded based on the pre-determined exclusion criteria, leaving 49 patients for analysis. Ketamine dosing ranged from 2.25 to 9.42 mg/kg (mean = 5.26 ± 1.65 mg/kg). Ketamine doses were not different between patients who required additional sedation ($n = 25$) or in patients who experienced an emergence reaction ($n = 4$). Although not statistically significant, there was a trend toward higher ketamine dosing in the three patients experiencing laryngospasm (7.58 vs. 5.11 mg/kg, $p = 0.17$). Ketamine dosing was not different for the 28 patients requiring medical admission compared to those discharged from the emergency department. Significant differences were noted between those who required intubation ($n = 14$, mean = 6.16 mg/kg) and those who did not ($n = 35$, mean = 4.9 mg/kg, $p = 0.02$). **Conclusion:** Our experience with intramuscular ketamine for prehospital chemical restraint demonstrates potential for loss of airway reflexes requiring intubation. This occurred at a statistically significant higher dose. A minimum effective dose was not identified. Prehospital providers should balance these risks with the need for immediate restraint and personal safety.

84. OUTCOMES FROM PREHOSPITAL USE OF HYDROXYCOBALAMIN FOR FIRE-ASSOCIATED CYANIDE POISONING IN A MAJOR METROPOLITAN EMERGENCY MEDICAL SERVICE

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Background: The combination of hypoxia, cyanide poisoning, and carbon monoxide poisoning is known to be lethal in animal models at sub-lethal doses. Hypoxia and carbon monoxide poisoning treatment can be initiated prehospital, but options for treatment of cyanide are limited. Few data from human subjects exist about the impact of hydroxocobalamin on survival of smoke inhalation victims. No data exist for prehospital administration in the United States. We report the effects on survival of patients suffering smoke inhalation who received hydroxocobalamin at the discretion of paramedics and other emergency medical service providers. We hypothesize that patients receiving hydroxocobalamin will have an improved survival and return of spontaneous circulation (ROSC) rates. **Methods:** We conducted a retrospective chart review and abstraction of a cohort of patients evaluated and treated with hydroxocobalamin for possible cyanide poisoning by the Houston Fire Department from February 2008 through November 2012. A convenience sample of subjects who received hydroxocobalamin prehospital or in the emergency center was included in the cohort. Subjects were identified by querying the HFD patient records database for administration of "hydroxocobalamin," "CyanoKit," "smoke inhalation," and "cyanide poisoning." The primary observation was survival at discharge. Secondary observations included presence of observed changes in patient status, initial presence of altered mental status (AMS), initial cardiac rhythm, and achievement of ROSC. **Results:** We identified 22 patients with fire-associated intoxication with a mean lactate of 10 ± 6.8 mg/dL. 11 (50%) who survived to discharge (3 with disability). 11 (50%) were found in cardiac arrest. 8 (72.7%) achieved ROSC after administration of hydroxocobalamin. 6 presented with an initial rhythm of asystole (80%), 4 with PEA (50%) and 1 with v. tach. Combined survival at discharge for PEA and asystole was 2 / 9 (22%). 5 of 8 patients with reported AMS

showed improvement of mental status after administration. **Conclusion:** Prehospital administration of hydroxocobalamin in the US has similar outcomes as previously reported by Fortin et al. Patients in asystole/PEA may achieve high ROSC rates with administration of hydroxocobalamin. This study is limited by its size, retrospective nature, and lack of baseline data.

85. DOES THE ARRIVAL BY EMERGENCY MEDICAL SERVICES IMPROVE COMPLIANCE WITH THE SURVIVING SEPSIS BUNDLE?

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Background: The positive role of emergency medical services (EMS) as front-liners in the identification and initial management of time sensitive conditions has been well described. The latest evidence-based clinical practice guidelines by the surviving sepsis (SSC) campaign have focused on the timely approach to the management of sepsis. The role of EMS in the management of severe sepsis and septic shock has not been well studied. Arrival of patients with severe septic shock by EMS will improve compliance with the sepsis resuscitation bundle, which includes the timely administration of intravenous fluids (IVF), antibiotics, and blood sampling for lactate level measurement and blood cultures, and, therefore, reduce mortality. **Methods:** We examined a cohort of patients who presented to the emergency department of an urban 1,000-bed academic trauma center with severe sepsis and septic shock as a part of an ongoing quality improvement project from January 1, 2011, through February 28, 2013. We collected data on the mode of arrival (EMS or non-EMS transportation), and we compared compliance with the SSC bundle and the mortality of the two groups. **Results:** Among the 436 patients included in our study, 134 (30%) arrived by EMS and the other 302 (70%) by non-EMS transportation. Compliance with the SSC bundle elements in the two groups was as follows: IVF (91% vs. 87%, $P = 0.19$), antibiotics (50% vs. 52%, $P = 0.81$), blood cultures before antibiotics (58% vs. 53%, $P = 0.31$), and time to measurement of lactate levels (73% vs. 57%, $P = 0.001$). Mortality did not differ significantly between the two groups (51% vs. 46%, $P = 0.29$). **Conclusions:** We could not demonstrate a difference between EMS and non-EMS transported patients with severe sepsis and septic shock regarding compliance with components of the SSC bundle except for time to blood sampling for lactate level measurement. We also found no difference in mortality between the two groups.

86. LIGHTS AND SIRENS RESPONSES ARE RARELY NEEDED FOR PATIENTS WITH A CHIEF COMPLAINT OF ABDOMINAL PAIN

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Background: The use of lights and sirens (L&S) by ambulances is meant to reduce transport times for unstable patients. However, L&S carries with it a higher risk of motor vehicle collision and injuries to both the EMS providers and the public. Ideally, one would reserve the use of lights and sirens for when it would affect clinical outcomes. Most EMS dispatch protocols are not evidence-based and are determined by expert consensus. We sought to create a decision rule so that emergency medical dispatch could identify patients who would benefit from lights and sirens transport. **Methods:** This was a chart review at a single sub-

urban EMS agency. We reviewed 394 charts of patients who had a chief dispatch complaint of "abdominal pain." Patients who were known to be pregnant or who had traumatic abdominal pain were excluded. A priori, we defined the need for a L&S response as being for patients who were in shock (SBP < 100 with end organ damage), who required direct admission to the operating room from the ED without the use of advanced imaging, STEMI, or who required emergency blood transfusion or admission to the ICU. Our goal was to create a dispatch rule with 99% sensitivity and 33% specificity (reduce L&S by one-third). **Results:** In our cohort study of 394 patients, 5 patients (2%) met the criteria for L&S response. Outcome patients had the following conditions: SBO (1), upper GIB (1), ruptured AAA (1), incarcerated hernia (1), intestinal perforation (1). We were unable to design a dispatch decision rule that captured all 5 patients with sufficient sensitivity. **Conclusions:** Although we were unable to design a dispatch rule with sufficient sensitivity, only 2% of patients in our analysis met our criteria for needing L&S response. Our analysis was limited by this being a single EMS and single hospital study. With a larger number of patients who met our outcome criteria for needing L&S response, we may have been able to design a dispatch rule that met our predefined standards. However, with only 2% of dispatches for abdominal pain requiring emergent treatment, it seems prudent to curtail lights and sirens responses for these patients.

87. ASSOCIATION BETWEEN ANTI-EPILEPTIC MEDICATIONS AND SEIZURES IN INTRACRANIAL HEMORRHAGE PATIENTS DURING CRITICAL CARE TRANSPORT

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Background: Seizures occur in 6% to 42% of patients with intracranial hemorrhage (ICH). Antiepileptic medications (AEDs) are commonly used for patients with ICH prior to or during interfacility transfer. There is a lack of evidence identifying the short-term benefits of AED administration by air medical services during interfacility transport. We aimed to identify the incidence of seizure during interfacility transfer of patients with ICH and determine the association of seizure occurrence with administration of AEDs before or during critical care air medical transport. **Methods:** We retrospectively reviewed 1,375 cases involving patients with CT-confirmed intracranial hemorrhage between 1/1/2010 and 12/30/2012 that were transferred to a tertiary care facility by a critical care air medical service. We identified the frequency of seizure occurring during transport and characterized these cases by describing patient age, sex, transport time, hemorrhage type, presence of trauma, AED use prior to transport crew arrival, and AED use during critical transport. We then analyzed the association of AED administration before or during transport with seizure incidence using Fisher's exact test (p -value < 0.05). **Results:** Of 1,375 cases with ICH, only 5 (0.36%) had a seizure during transport. The median time-in-transfer (from transport team arrival at bedside to transfer of care at the receiving facility) was 47 minutes (IQR 38, 59). Of patients that sustained seizure in-transfer, mean age was 45 (range 33-50) and 3 were males. Patients had subarachnoid hemorrhage (1), subdural hematoma (1), intraparenchymal hemorrhage (2), or multiple hemorrhages (1), and only one was traumatic. Of all cases, 283 (21%) received AED (phenytoin or levetiracetam) before or during transport. Three patients experiencing seizure in-transfer received AED prior to arrival (1) or during transport (2). Seizure

incidence during transport appeared to be independent of AED administration ($p = 0.275$). **Conclusions:** Seizure incidence during transport of patients with ICH is an infrequent occurrence. Antiepileptic medication administration before and during transport was not associated with seizure during transport. These data fail to support prophylactic administration of antiepileptic medication during critical care transport of patients with intracranial hemorrhage.

88. PERCEPTION OF INTRANASAL MEDICATION EFFICACY BY PREHOSPITAL PROVIDERS

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Background: Intranasal (IN) medication administration in emergency medical services (EMS) is increasing. Previous studies have shown the pharmacologic efficacy of IN administration compared to other parenteral methods of medication administration. No study to date has evaluated the perception of IN medication administration by EMS providers, which could have significant impact on its use in the prehospital setting. The objective was to determine the practices and perceptions of IN medication administration by EMS providers. **Methods:** An online survey tool was sent to all advanced prehospital providers in the region. These providers were questioned about their experiences with IN medication administration and their perceptions of the efficacy and efficiency of this route of administration. Descriptive statistics were used to analyze the results. Providers were also urged to provide unstructured feedback about their views. **Results:** Surveys were distributed to 823 email addresses; 48 "bounced," leaving a total of 775. 315 (40.6%) providers completed the entire survey. While 311 (96.3%) providers have had formal IN administration training, only 260 (79.8%) have performed the skill. Of the providers who have IN administration experience, the majority reported positive experiences with administration of naloxone, fentanyl, and midazolam ($p < 0.001$). Providers did not have a positive experience or perception with IN administration of glucagon ($p = 0.77$). Of concern, 40 providers (12%) believed that morphine could be given IN. In the unstructured feedback section, there was a range of responses, including a preference to use IN administration in pediatric patients or in those in whom IV access is difficult to obtain, as well as making more medications available by intranasal route. **Conclusions:** The use of IN medication administration has increased significantly in last few years. Studies have shown its efficacy in the clinical setting, and there is clear reduction in risk of needle stick to the provider; there seems to be buy-in of its usefulness clinically, but we must assure clear understanding of the physiology of the medications, so only medications absorbed through the mucosa are administered IN. The data collected shows that providers have a generally positive perception of IN medication administration.

89. MOBILE INTEGRATED HEALTH-CARE PRACTICE FOR TRANSITIONS OF CARE AND READMISSION REDUCTION: A FEASIBLE MODEL FOR IMPLEMENTATION AND DEVELOPMENT

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Background: Effective transition of care between health-care settings is increasingly recognized as a critical component of high-quality health care. Mobile Integrated Healthcare Practice (MIHP) is an emerging practice model for improving transition from the inpatient setting by positioning emergency medical services (EMS) providers as the cornerstone of care coordination. EMS uniquely impacts care transitions because of its role at the intersection of the inpatient, outpatient, and home environments. This abstract describes the process for development of an MIHP for an urban congestive heart failure (CHF) population. **Methods:** Patients with CHF at a single urban academic center were identified as a population that could benefit from optimized transition care based upon historic readmission rates. An interprofessional working group, including EMS, conducted a 9-month needs assessment. The team identified previously validated interventions that had been offered with limited integration and bundled these interventions into a comprehensive care program led by EMS. Unique to this pilot, EMS integrates services provided by home health, pharmacy, social work, cardiology, hospitalist, emergency medicine, and hospital administration. The pilot was self-funded by MIHP stakeholders based on the assessed value to the CHF patient and the hypothesized improvement in readmission rates. **Results:** Under this model, EMS performs an in-home assessment for readmission risks, patient mobility limitations, and home medications/oxygen. EMS also initiates home telemonitoring and reviews the follow-up care plan and discharge instructions with the patient. If any element is deemed inadequate by EMS, a centralized call center mobilizes need-matched resources to the patient in a time-appropriate interval. Specific members of the interprofessional team then address a patient's individual needs. **Conclusions:** This demonstrates that an interprofessional care team with EMS as a lead stakeholder can integrate best practices for transitions of care to develop a MIHP pilot for the care of CHF patients at an urban academic medical center. Coordinated interprofessional involvement in the development of a bundle of validated interventions leads to need-matched resource allocation, as identified by EMS providers. We describe a feasible model for the development of a coordinated care transition program with EMS as a lead partner.

90. FIRST-RESPONDER ACCURACY USING SALT AFTER BRIEF INITIAL TRAINING

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Background: Mass-casualty incidents (MCIs) present a unique challenge in terms of triage and response for the medical community. The Centers for Disease Control and Prevention in the United States recently proposed a mass-casualty triage tool entitled SALT (sort, assess, life-saving interventions, treatment, and/or transport) to equip responders with a consensus triage strategy. Paramedics and emergency physicians have been shown to accurately apply SALT, but first responders to MCIs may also include police and fire services with varying levels of medical training. The objective of this study was to determine if students enrolled in paramedic, fire, and police training programs could accurately apply SALT. **Methods:** All students enrolled in the primary care paramedic (PCP), fire, and police foundation programs at two community colleges were invited to participate in a 30-minute didactic session on SALT. Immediately following this session, a 17-item test was administered to as-

sess the student's ability to understand and apply SALT. General linear models with repeated measures were used where appropriate and chi-square tests were used to compare the proportion of errors made among respondents. **Results:** 464 trainees completed the test. The mean (SD) test score for all respondents was 75.0% (15.9). Test scores were higher for PCPs (87.0%) compared to Fire (80.2%) and Police (68.0%). Fire trainees scored significantly higher compared to Police trainees (12.2%; 95% CI: 8.3, 16.2). When responders were asked to assign triage categories to 10 paper-based clinical scenarios, over-triage errors occurred in 13.5% of responses, compared to under-triage in 8.5%. Critical errors, defined as erroneous triage resulting in irrevocable detriment to patient morbidity or mortality were rare, occurring in 0.9%, 1.7%, and 5.2% of PCP, Fire, and Police responses, respectively. **Conclusions:** Among first-responder trainees, PCPs are able to apply SALT with the most accuracy, followed by Fire and then Police. Over-triage is the most frequent error, while critical errors are rare. Standardizing SALT across agencies and jurisdictions may lead to decreased confusion, more efficient and accurate prehospital care, and improve destination decision-making for first-responders involved in a MCI.

91. DISASTER PREPAREDNESS AND NEEDS ASSESSMENT OF OLDER ADULTS

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Background: The elderly population has proven to be vulnerable in times of a disaster. Many have chronic medical problems for which they depend on medications or medical equipment. Some older adults are dependent on care givers for managing their activities of daily living (ADLs) such as dressing and instrumental activities of daily living (IADLs) such as transportation. A coordinated effort for disaster preparation in the elderly population is paramount. We sought to assess the potential needs and plans of older adults in the face of a local disaster. **Methods:** The setting is a community-based, university-affiliated urban ED (emergency department) that sees more than 77,000 adult patients per year. We distributed a survey on disaster plans and resources needed if evacuating 100 community-residing ED patients and visitors age 65 years and older from January to July 2013. We report means and proportions with 95% confidence interval (CI). **Results:** We collected data from 13 visitors and 87 patients. The mean age was 76 and 54 were female. Thirty-one responded that they had a disaster plan in place (31/100, CI 22.4-41.4%). Of those 31, 94% (29/31 CI 78.6-99.2) had food and water as part of their plan, 62% (19/29, CI 42.2-78.2) had a supply of medication and 35% (12/31, CI 21.8-57.8) had an evacuation plan. When asked what supplies the 100 subjects might need if evacuated, 33% (CI 23.9-43.1) needed a walker, 15% (CI 8.6-23.5) a wheelchair, 78% (CI 68.6-85.7) glasses, 17% (CI 10.2-25.8) a hearing aid, 16% (CI 9.4-24.7) a glucometer, 93% (CI 86.1-97.1) medication, 14% (7.8-22.4%) oxygen, 23% (CI 15.2-32.5) adult diapers, and 21% (CI 13.2-30.3) had medical equipment that required electricity. Many of the subjects also required help with one or more of their ADLs, the most common being dressing (17%, CI 10.3-26.1) or their IADLs, the most common being transportation (39%, CI 29.7-49.7%). Only 42% (CI 32.3-52.7) were interested in learning more about disaster preparation. **Conclusions:** The minority of the older adults in our study population had a disaster plan in place. Most of the respondents

would require medications and many would require medical supplies if evacuated.

92. THE IMPACT OF PRE-ARRIVAL DISPATCH-ASSISTED CPR ON BYSTANDER CPR RATES, TIME TO STARTING CPR, AND SURVIVAL FROM OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Bystander CPR (BCPR) strongly influences survival from OHCA yet is provided in a minority of cases. The AHA has promulgated guidelines on provision of pre-arrival hands-only dispatcher-assisted telephone CPR (TCPR) instructions to increase the proportion of arrests receiving early BCPR; however, the impact of those guidelines is unknown. **Objective:** Evaluate the impact of implementing the TCPR guidelines on recognition of OHCA by 9-1-1 dispatchers, time from call receipt to giving TCPR instructions, time to first chest compression (CC), prehospital return of spontaneous circulation (ROSC), survival, and favorable neurological outcome (FNO). **Methods:** Dispatch audio records of OHCA in 3 large dispatch centers in Arizona (10/10-11/12) were reviewed using a standardized time-stamp methodology. Data were entered into a structured TCPR database linked to EMS and hospital outcome data. Intervention: Implementation of a 2-hour individual dispatcher training and a guideline-based change in dispatch protocol. **Results:** There were 860 pre-implementation (P1) and 799 post-implementation (P2) cases. A total of 1,265 cases met inclusion criteria. Outcome data collection and linkage is ongoing: ROSC, survival, and neurological outcomes were available in 26%, 24%, and 22% of cases, respectively. The proportion of cases receiving TCPR increased: P1 (28.7%); P2 (49.9%, $p < 0.001$). Median time to beginning TCPR instructions decreased significantly: P1 (153 sec); P2 (129 sec, $p < 0.001$) as did median time to first CC: P1 (198 sec); P2 (162 sec, $p < 0.001$). Outcomes—ROSC: P1 16.9% vs. P2 25.5% (adjusted OR = 1.68; 95% CI: 0.96, 2.95); Survival to hospital discharge: P1 8.2% vs. P2 13.2% (adjusted OR = 1.97; 95% CI: 0.83, 4.67); Good neurological outcome: P1 6.6% vs. P2 11.5% (adjusted OR = 2.57; 95% CI: 0.92, 7.19). **Conclusions:** The implementation of the AHA pre-arrival TCPR guidelines was associated with a significant improvement in the time-to-CPR instructions and time-to-first CCs and rate of provision of dispatch-assisted bystander CPR. This small, preliminary analysis of prehospital ROSC, survival, and FNO revealed higher, but statistically non-significant, rates after the interventions.

93. TELEPHONE CPR INSTRUCTIONS FOR OUT-OF-HOSPITAL CARDIAC ARREST: A SURVEY OF PUBLIC SERVICE ANSWERING POINTS IN THE UNITED STATES

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Background: The 2010 AHA ECC guidelines identify CPR pre-arrival instructions (PAIs) as an important intervention to increase bystander CPR rates and as an integral component of the "chain of survival." The number of 9-1-1 dispatch centers providing CPR PAIs along with the quality of those instructions is largely unknown. We performed a nation-wide survey of PSAPs (public service answering points) in the US focusing on the current practice and resources available to provide PAIs to 9-1-1

callers. **Methods:** This survey was conducted in 2010. 5,686 PSAPs were identified, and 3,555 had valid e-mail addresses and were contacted. Each received a preliminary email announcing the survey, an e-mail with a link to the survey, and up to three follow-up e-mails for non-responders. The survey contained 23 validated questions with sub-questions depending on the response selected. **Results:** Of the 5,686 identified PSAPs in the United States, 3,555 (62%) received the survey, with 1,917/3,555 (54%) responding. Responding agencies represented all 50 states and the District of Columbia. Nearly all were public agencies (n = 1,883, 99%). 879 (46%) responding agencies reported that they provide no PAs for medical emergencies, and 273 (31%) of these reported that they were unable to transfer callers to another resource to provide PAs. 975/1005 (97%) respondents reported that they provided PAs for OHCA: 66 (7%) of these provided compression-only CPR instructions, 698 (69%) reported conventional CPR instructions (chest compressions with rescue breathing), 166 (17%) report some other instructions incorporating ventilations and compressions, and 75 (7%) did not specify the type of PAs provided. A telephone validation follow-up of non-responders showed no substantial difference in the provision of PAs for OHCA by non-responders. **Conclusions:** To our knowledge, this survey represents the first comprehensive, nationwide assessment of the current practices of PSAPs in the US regarding PAs for OHCA. These data show that there is significant variability in the delivery of CPR PAs in the US. This may provide a significant opportunity to improve bystander CPR rates and outcomes from OHCA.

94. A MULTIDIMENSIONAL APPROACH TO EFFECTIVELY ENHANCED A-CPR

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Background: The better detection of out-of-hospital cardiac arrest (OHCA) situation through emergency medical service (EMS) calls by dispatchers may influence the performance of online dispatcher-assisted cardiopulmonary resuscitation (DA-CPR). In an EMS system with a DA-CPR proportion around 25% for OHCA, we launched a multidimensional approach for better detection of cardiac arrest by EMS dispatchers and assess its impact on DA-CPR. **Methods:** The EMS authority implements a multidimensional approach for cardiac arrest detection, including 1) a modified simple protocol for breathe and consciousness identification, 2) post hoc auditing of the audio records of EMS calls sampled by the medical director among those proved OHCA upon EMS paramedics' contact, 3) feedback to each dispatcher on audio record audits, and a written response by the dispatchers, 4) a leadership strongly supporting this, 5) modifying the computerized dispatch operational system to highlight the presence of normal breaths, and 6) adding an icon for reassurance if the call is unnecessary for DA-CPR before call close in the computerized system. Setting: A centralized and computerized-assisted dispatch system in a metropolitan EMS with a 2.68 million population in 272 square kilometers. Usually the dispatchers are requested to send out a responding ambulance within 60 seconds after receiving an EMS call. **Methods:** The proportion of DA-CPR for OHCA patients 6 months after the intervention is compared with that for the same month period of last year as the control group, using regression analysis for statistics. **Results:** A total of 463 OHCA patients after the intervention are compared

with the 471 OHCA in control. The proportion of DA-CPR after the intervention (44.3%) is significantly higher than that (27.2%) of control (proportion difference: 17.1%, 95% CI: 11.0-23.0%). **Conclusions:** We demonstrate a multidimensional approach including protocol, leadership, audit, feedback, breath status targeted, and reassurance assessment may significantly enhance the proportion of DA-CPR for OHCA.

95. DISPATCHER-ACTIVATED NEIGHBORHOOD ACCESS TO DEFIBRILLATION AND CARDIOPULMONARY RESUSCITATION: A FEASIBILITY STUDY

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Background: A population-based, before-and-after trial, dispatcher-activated neighborhood access defibrillation and cardiopulmonary resuscitation (NAD-CPR) was implemented targeting OHCA in a city (10 million populations). The trial has three components: 1) registration of CPR supporters (who want to run to scene for performing CPR), 2) registration of NAD/NAD providers (who want to run to scene with NAD), and 3) activation protocol by dispatch center, which detects OHCA, tracks the GIS information of patients and the nearest NAD, and sends a short text message to registered CPR supporters and NAD providers within a 300-meter distance. We assessed the feasibility of the former two components prior to implementing whole intervention. **Methods:** The three feasibility studies were performed from March to December 2012. A telephone survey on the willingness to be CPR supporters using a designed questionnaire was performed. Targets are randomly sampled among CPR trainees, and the survey included demographics and willingness attitude. A pilot registration of CPR supporters was done in one training center. Demographics, cell phone number, and home and office address were registered. A pilot registration of NAD/NAD providers was encouraged for owners to register the NAD with health authorities, providing an exact address and potential NAD providers' cell phone numbers. Study outcomes are willingness and registration rate of CPR supporters among CPR trainee, and registered NAD/NAD providers. We described the demographics and outcomes. **Results:** Total 146 (66.7%) trainees (52.1% male and average 36.9 years old) responded among a random sample of 212 (5% from a total 4,240 CPR trainees. Positive willingness for being CPR supporters was 57.5% for daytime and 56.5% for nighttime, and 71.9% for home and 69.9% for office location. Among 4,167 CPR trainees, 2,151 (51.6%) were registered as CPR supporters (mean 34 years). In total, 75.9% registered home address, 81.1% registered office address, and 57.0% registered both. In total, 3013 PAD/ PAD providers in the city were successfully registered, with 33% in public places and 77% in private places. **Conclusions:** The study for NAD-CPR trial showed high willingness and registration rate of CPR supporters and registration of NAD/NAD providers.

96. EFFECT OF DISPATCHER-ASSISTED BYSTANDER CARDIOPULMONARY RESUSCITATION BETWEEN PUBLIC VERSUS HOME BYSTANDERS ON OUTCOMES AFTER OUT-OF-HOSPITAL CARDIAC ARREST: A NATIONWIDE OBSERVATIONAL STUDY

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Background: Bystander cardiopulmonary resuscitation (BCPR) with dispatcher assistance (DA) has been known to improve outcomes after OHCA in a community through spreading bystander CPR. Previous studies reported that BCPR with DA had an equivalent effect to BCPR without DA on outcomes. It is unclear whether the BCPR with DA between specific bystander groups (public versus home) is associated with better outcomes or not. **Methods:** Adult OHCA with cardiac etiology, treated by EMS providers, and received bystander CPR in a nationwide OHCA registry from Sep. 01 to Dec. 31, 2012, were analyzed. We excluded patients who were 18 years old and younger, whose arrest was witnessed by EMS providers, and for whom no information was provided about hospital outcomes or place of event. Eligible patients were selected from a nationwide OHCA registry and merged with a dispatch registry. Bystander CPRs by place and DA are categorized into four groups: public-DA, home-DA, public-NDA, and home-NDA. The primary and secondary endpoints were survival to discharge and good neurological recovery at hospital discharge by the CPC 1 and 2. Multivariable logistic regression analysis was modeled to determine the association between bystander group and outcomes and to calculate ORs and 95% CIs, adjusting for potential confounders. **Results:** Of EMS-treated patients with cardiac etiology (n = 5,232), a total of 1,171 patients (22.4%) were analyzed (male 64.6% and average age 65.9 ± 15.7 years), excluding unknown information on place (n = 313), arrests witnessed by EMS providers (n = 241), 18 years old and younger (n = 101), and not receiving BCPR (n = 2,866). Survival-to-discharge rate and good neurological recovery were 7.0% and 3.8% (16.2% and 12.0% in public-DA (n = 117), 4.5% and 2.0% in home-DA (n = 508), 10.8% and 7.0% in public-NDA (n = 286), and 5.8% and 2.6% in home-NDA (n = 800) (each p < 0.001)), respectively. The adjusted ORs for survival to discharge compared with home-NDA group were 0.80 (0.34-1.86) in public-DA, 0.36 (0.18-0.71) in home-DA, and 0.84 (0.44-1.59) in public-NDA, respectively. The adjusted ORs for good neurological recovery compared with home-NDA group were 1.87 (0.63-5.58) in public-DA, 0.34 (0.12-0.94) in home-DA, and 1.31 (0.57-3.04) in public-NDA, respectively. **Conclusions:** Patients who received home BCPR with DA were associated with worse hospital outcomes than patients who received home BCPR without DA. The study findings suggest home bystanders may be associated with lower quality CPR and followed by poor outcomes when they receive CPR instruction via telephone.

97. ALTERNATIVES TO TRADITIONAL EMS DISPATCH OR TRANSPORT TO THE EMERGENCY DEPARTMENT: A SCOPING REVIEW OF PUBLISHED OUTCOMES

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Background: Expanded-scope EMS programs are being widely implemented. The existing body of research has been described as weak. The objective of this scoping literature review was to catalogue all outcomes used to measure alternatives to EMS dispatch and/or transport, with a goal to provide researchers and program leaders with a catalogue of outcomes that can be measured. **Methods:** Systematized bibliographic searches were conducted in PubMed, Embase, CINAHL, and the Cochrane Library using a combination of MeSH and keywords. The gray literature search included a list of websites developed by the study team. The

bibliographic and gray literature searches were purposefully broad. Inclusion criteria for articles and reports were that the study population involves 9-1-1 callers/EMS patients, the document reports on alternatives to traditional ambulance dispatch OR traditional ambulance transport to the ED, and the document reports an outcome measure. The reports were categorized as either alternative to dispatch or to transport, and outcomes were categorized and described. **Results:** The bibliographic search retrieved 8,773 titles, from which 134 titles were selected for further review. From these, 61 abstracts were retrieved, out of which 27 full text articles were included. In the gray literature search, 31 websites were identified, from which four met criteria and were retrieved. Eleven reports described alternatives to EMS dispatch, which measured the following outcomes: clinical (n = 1), safety (n = 2), time (n = 1), service utilization (n = 5), patient satisfaction (n = 1), cost (n = 3), accuracy of decision (n = 7), and process outcomes (n = 1). Twenty reports described alternatives to EMS transport, which measured the following outcomes: clinical (n = 7), safety (n = 5), time (n = 7), service utilization (n = 8), patient satisfaction (n = 1), cost (n = 3), accuracy of decision (n = 2), process outcomes (n = 5), other (n = 2). **Conclusions:** For programs which provide an alternative to EMS dispatch and transport, reported outcomes were catalogued and described. Future researchers and program leaders should achieve consensus on uniform outcome measures, to allow benchmarking and comparison across programs.

98. BARRIERS TO SELF-REPORTING SAFETY EVENTS BY PARAMEDICS

Julie Sinclair, Christopher Bourque, Lisa Calder, Michael Austin, Andrew Reed, Jennifer Kortko, Justin Maloney, Regional Paramedic Program of Eastern Ontario

Background: Strategic priorities to address patient safety issues in EMS have recently been emphasized, but little research exists examining the extent to which patient safety events occur within EMS and even fewer studies investigate patient safety systems for self-reporting by paramedics. The purpose of this study was to identify the barriers to paramedic self-reporting of patient safety events; specifically, patient care variances (PCVs), near misses and adverse events. **Methods:** The survey describes one of five different patient safety event clinical scenarios (near miss, adverse event, minor, major, or critical PCV) and lists 18 potential barriers to self-reporting as closed-ended questions. These include 11 fear-based barriers and were presented for rating on a 5-point Likert scale. The surveys were randomly distributed to 1,153 paramedics during the 2012 continuing medical education (CME) sessions. Data analysis consisted of descriptive statistics, chi-square tests, and Mann-Whitney tests, where applicable. **Results:** We received responses from 1,133 paramedics (98.4%). Almost one-third (28.2%) were advanced care paramedics and 45.0% had more than 10 years' experience. The top five barriers to self-reporting (very significant or significant) (n,%) were fear of being punished (905, 79.9%), fear of being suspended and short-term income loss (890, 78.6%), fear of a Ministry of Health and Long Term Care (MoHLTC) investigation (882, 77.9%), fear of termination and long-term income loss (880, 77.7%), and fear of deactivation (869, 76.7%). Overall, 64.2% responded they would self-report the patient safety event. Intention to self-report varied according to the patient safety event clinical scenario (22.3% near miss, 46.0% adverse event, 73.3% minor PCV, 85.7% major PCV, 93.2% critical PCV). No association was found between the scope of practice and intention to self-report

(p = 0.55). **Conclusions:** A high proportion of fear-based barriers exist to self-reporting of patient safety events, suggesting that a culture change is needed to facilitate the identification of future patient safety threats.

99. TIME OF DAY TRENDS IN AMBULANCE DEMAND

Kate Cantwell, Ameer Morgans Benetas, Karen Smith, Paul Dietze Michael Livingston, Ambulance Victoria

Background: Occupational, social, and recreational routines follow temporal patterns, as does the onset of certain acute medical diseases and injuries. It is not known if the temporal nature of injury and disease transfer into patterns that can be observed in ambulance demand. We sought to determine whether distinct disease or injury temporal patterns could be observed in ambulance demand. **Methods:** All cases attended by Ambulance Victoria between January 2007 and December 2011 in metropolitan Melbourne were extracted from the Ambulance Victoria data warehouse. Data on time of call, cause, and final primary assessment (paramedic "diagnosis") were analyzed. **Results:** This study used over 1.2 million records. Distinct temporal patterns of disease and injury were observed in ambulance demand. Overall ambulance demand was at its lowest at 5am and then peaked at 11am. Distinct patterns were seen when data was analysed by final primary assessment. Cardio-vascular events were more frequent in the mornings. Motor vehicle crashes had their highest frequency at 1700 hours. Mental health cases peaked in the evenings. Fevers, coughs, and shortness of breath cases were significant contributors to demand in the late evenings and early mornings. The frequency of trauma cases increased on weekends; medical cases had a higher frequency during the week, with the highest on a Monday. Age was an important factor in time of day patterns seen. Many disease patterns with a morning peak of calls also had an older average age. Some patterns with no obvious morning peak showed a morning peak for elderly callers when analyzed by age category. **Conclusions:** Time of day patterns can be observed in ambulance demand when analyzed by disease, injury type, or external cause. The effect of age should be considered when analyzing temporal patterns. Organization of quantity and skill set of responding ambulances during certain hours of the day should take into account the specific demand distribution of certain acute diseases and injuries. This research can be used by ambulance services, emergency departments, and primary health-care services to inform practice around demand management strategies and service delivery.

100. FACTORS THAT PREDICT PREHOSPITAL PARAMEDIC IV CANNULATION SUCCESS: A RETROSPECTIVE ANALYSIS

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Background: Intravenous (IV) cannulation is an enhanced paramedic skill required for the administration of IV medications and fluids in the prehospital setting. Despite this, IV proficiency is variable among providers and the factors contributing to IV success have yet to be defined. The objective of this study was to determine paramedic factors associated with successful IV cannulation in the prehospital environment. **Methods:** This was a retrospective review of data gathered from 6 emergency medical services from a Regional Base

Hospital Program from April 2011 to March 2012. Paramedics not certified in IV cannulation and those who attempted less than 3 IV cannulations were excluded. IV success was defined as successfully catheterizing a patient's vein in 75% of the attempts made over the study period. Backward stepwise multivariable logistic regression models determined predictor variables independently associated with successful IV cannulation in the prehospital setting. **Results:** 353 paramedics performed a total of 12,728 IV attempts over the 1-year study period. 85 (24.1%) were advanced care paramedics (ACPs) and 268 (75.9%) were primary care paramedics. 271 (76.8%) were full-time employees. Paramedic training level, years since IV certification, call volume, error rate, number of IV attempts, proportion of high acuity calls, proportion of older patient (= 75 years) calls, and the proportion of calls in an urban setting were variables included in the adjusted model. ACP certification (OR: 3.1, 95% CI: 1.7, 5.5) and IV attempts = 40 the (OR: 2.0, 95% CI: 1.1, 3.4) were independently associated with IV success. **Conclusions:** Two paramedic factors were independently associated with successful IV placement. These factors should be considered when developing training benchmarks for skill development and maintenance.

101. EFFECTS OF THE USE OF THE RICHMOND AGITATION SEDATION SCALE (RASS) ON TIME TO POST-INTUBATION SEDATION IN THE PREHOSPITAL SETTING

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Background: Numerous adverse effects are associated with inadequate sedation following endotracheal intubation, such as unplanned extubation, resistance to ventilation, and emergence with inadequate pain control. Through service quality improvement activities, opportunities for improvement were identified in post-intubation sedation times. We examined the effects on post-intubation sedation times when the Richmond Agitation Sedation Scale (RASS) score was introduced in a critical care transport service. **Methods:** We incorporated serial assessments of the RASS score every 5 minutes as a mandatory documentation requirement for all intubated transported patients. Crew members received instruction on RASS assessment and prehospital sedation goals. All times between sedation dosages were collected on these patients transported between October 2012 and June 2013. Comparison was made between the dosing intervals of each sedation drug provided by the crew pre and post introduction of RASS. **Results:** A total of 165 intubated patients were transported during the study period of 10/1/2012 through 7/1/2013. Between October and December 2012, prior to use of RASS, the average time to sedation was 12 minutes, with longest time being 20 minutes. RASS was implemented in January 2013 after instruction and documentation changes occurred. Between January and July there was an incremental reduction in sedation times, reflecting more proactive sedation. Between January and April average time to sedation was 7 minutes, with longest time of 10 minutes. Between May and July, the average time to sedation was 4 minutes, with the longest time being 8 minutes. **Conclusions:** Introduction of RASS score monitoring in transported intubated patients resulted in a decrease in average time to sedation administration from 12 to 4 minutes, resulting in improved sedation during transports. The RASS score has been validated in routine monitoring of ICU patients and was easy to implement in the prehospital setting. Introduction of RASS along with documentation

requirements led to increased proactive sedation management and a safer transport environment for patients and providers.

102. A PROSPECTIVE EVALUATION OF THE UTILITY OF THE AMBULANCE CALL RECORD TO CHANGE THE MANAGEMENT OF PATIENT CARE IN THE EMERGENCY DEPARTMENT

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Background: The objective of this study was to determine how often the ambulance call report (ACR) is available to the emergency department (ED) physician at initial assessment and to determine if the ACR contains information that could change the ED management of patients. **Methods:** This was a prospective cohort study of adult patients arriving at one of two EDs at a tertiary care center (annual census 125,000) by ambulance. At this center, electronic ACRs are faxed to the ED upon completion and added to the patient's chart by ED staff. Physicians were asked to complete a data collection form for each patient regarding ACR availability and the perceived value of the ACR. This 4-week study began in July 2012, shortly after the implementation of a new electronic ACR handover process (round 1). To control for any confounding factors related to the implementation of this new eACR handover process, the study was repeated in February 2013 (round 2). **Results:** 869 forms were collected; 545 in round 1 and 324 in round 2. The ACR was available at first physician assessment for 82 (15.0%) patients in round 1, compared to 76 (23.5%) patients in round 2 (88%, 95% CI: 3%, 14%). The ACR was available at some point during patients' ED stay for 154 (28.3%) patients in round 1, compared to 111 (34.5%) patients in round 2 (86%, 95% CI: 0.3%, 12.4%). Of patients that had an ACR available ($n = 265$), physicians reported that information changed or altered their treatment plan in 76 (28.7%) cases. When an ACR was not available, 63.9% of physicians reported that the ACR would have provided valuable information, such as patient history (72.3%) and vital signs (69.2%). In 411 (50.5%) cases, the physician received neither verbal handover from a nurse or paramedic nor an ACR. There were only 56 (6.9%) cases where the physician received both verbal handover and an ACR was available. **Conclusions:** Although the ACR contains clinically relevant information that may change or influence ED management, physicians often assess, treat, and disposition patients without receiving the ACR.

103. FREQUENCY OF PERFORMANCE OF DELEGATED MEDICAL ACTS BY PRIMARY CARE PARAMEDICS IN A REGIONAL BASE HOSPITAL PROGRAM

Don Eby, Tracy Gaunt, Al Rice, Shelley McLeod, Southwestern Ontario Regional Base Hospital Program

Background: Competence to perform delegated medical acts (DMAs) is believed to be related to frequency of practice. Although attempts have been made to establish minimum frequency benchmarks, the frequency of skill performance has rarely been reported in the prehospital literature. The objective of this study was to report the frequency of calls where primary care paramedics (PCPs) performed DMAs. **Methods:** A retrospective review was conducted of 27,628 ambulance call reports over 2 years (April 2011–March 2013). These were completed by PCPs employed in 7 EMS agencies and overseen by a regional base hospital program. Two EMS agencies covered large urban areas, 1 agency was exclusively ru-

ral, and 4 agencies were mixed urban and rural. Data was abstracted from a regional electronic database containing 100% of calls where DMAs were performed. A DMA included administration of ASA, nitroglycerin, salbutamol, glucagon, 50% dextrose, glucose gel, diphenhydramine, dimenhydrinate, or epinephrine or use of a semi-automatic defibrillator by PCPs. **Results:** There were 817 PCPs included in the review for 2011-2012 and 822 PCPs included in the review for 2012-2013. For 2011-2012 and 2012-2013, respectively, 647 (79.1%) and 571 (69.5%) PCPs were the attendant on 2 or less calls per month where a DMA was performed. The median (IQR) number of calls involving a DMA per year per paramedic were 13 (5, 22) for 2011-2012, and 15 (6, 27) for 2012-2013. The most frequent DMAs involved drug administration. The median (IQR) number of calls per year per paramedic when ASA was administered was 4 (2, 8) calls, nitroglycerin 2 (1, 5) calls, and salbutamol 2 (1, 5) calls. In 2012-2013, 117 (14.2%) PCPs gave at least 1 dose of epinephrine (range 0-6), and 299 (36.4%) PCPs gave at least 1 dose of glucagon (range 0-7). **Conclusions:** PCPs in the regional program undertook DMAs infrequently. If competence to perform skills is related to frequency of use, the low frequency of performance of DMAs by PCPs raises issues of how to ensure and maintain competent performance. This has implications for ongoing re-certification, continuing education, and skill practice.

104. USE OF A MOBILE APPLICATION TO STUDY SLEEP AND FATIGUE IN EMS PROVIDERS

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Background: To determine the feasibility of using a smartphone mobile application to collect sleep, fatigue, and injury data from emergency medical services (EMS) workers. **Methods:** We developed a mobile smartphone application for Android-type devices. Eligibility criteria included EMS workers employed in one large urban area, >18 years of age, who owned and operated an Android-type smartphone. The mobile application was installed onto devices and subjects used the application to document shift, sleep, and fatigue data before, during, and after scheduled shifts for 30 consecutive days. We used validated items to measure sleep and fatigue derived from the Chalder Fatigue Questionnaire and the Fatigue Impact Scale. Subjects were provided modest cash incentives. We describe compliance with data entries and describe variation in sleep and fatigue measures over time using descriptive statistics. **Results:** We enrolled 9 nine subjects (3 females) aged 29 (SD 10) years and with 8.5 (SD 10) years EMS experience. Seven subjects installed the application and successfully transmitted data. Subjects scheduled an average of 10 shifts during the 30-day study period (total 74, min 5, max 15). Pre-shift sleep hours were transmitted for 73 of 74 shifts (99%). Post-shift fatigue responses were transmitted for 65 of 74 shifts (88%). Complete pre-shift and post-shift data was obtained for 62 shifts (84%). Subjects reported a mean of 6 hours of sleep. One subject reported ≤ 4 hours of sleep prior to work for 90% of pre-shift entries. Post-shift fatigue scores varied within and between subjects over time. Fatigue scores for two subjects indicated severe mental and physical fatigue for a single shift. There were no injuries reported during the study period. **Conclusions:** Wide variability in pre-shift sleep and post-shift fatigue scores within and between subjects provides evidence for experience sampling of sleep and fatigue among EMS workers. Compliance with

data entry in this pilot study suggests that using a smartphone mobile application to collect sleep, fatigue, and injury data from EMS workers is feasible.

105. THE FREQUENCY OF CRITICAL PROCEDURES PERFORMED BY PARAMEDICS IN A HIGH-VOLUME EMS SYSTEM

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Background: Maintaining procedural competency is vital to the practice of emergency medicine, both for hospital-based and pre-hospital providers. In a high-volume, urban EMS system with an increasing number of paramedics and short transport times, individual paramedics may have difficulty maintaining their skills for certain lifesaving procedures with live-patient encounters. The objective of this study was to describe current provider-level data for critical procedures performed in a high-volume EMS system. **Methods:** A retrospective review of electronic medical records from January 1, 2012 through December 31, 2012 from the Los Angeles Fire Department (LAFD), which has 1,105 paramedics serving a population of 3.8 million (0.29 paramedics per 1000 residents), was used to quantify attempts and successful performance of five critical procedures. These included endotracheal intubation, supraglottic airway (SGA) placement using the King airway, cardioversion, transcutaneous cardiac pacing, and needle thoracostomy. Primary outcome measures were the cumulative frequency of each procedure and the frequency performed per paramedic. **Results:** During the 12-month study period LAFD responded to 319,000 EMS incidents, resulting in 193,300 patient transports. During this time, paramedics performed 821 critical procedures. This included 966 endotracheal intubations performed by 456 paramedics, 667 supraglottic airway placements performed by 359 paramedics, 28 cardioversions performed by 24 paramedics, 54 external cardiac pacing events performed by 43 paramedics, and 36 needle thoracostomies performed by 27 paramedics. 59% of paramedics did not perform a single endotracheal intubation, 68% did not place an SGA, 97% did not perform a cardioversion, 95% did not perform external cardiac pacing, and 97% did not perform a needle thoracostomy. **Conclusions:** Critical perishable skills, while potentially life-saving, were rarely performed by individual paramedics in our large urban EMS service. Paramedics are at significant risk for skill deterioration, and new personnel are unlikely to achieve competence in the performance of critical procedures if clinical exposure is the sole basis for the attainment of skill.

106. A DESCRIPTION OF VIOLENCE TOWARDS EMERGENCY MEDICAL SERVICES PROFESSIONALS

Remle Crowe, Jennifer Eggerichs, Mirinda Gormley, Severo Rodriguez, Melissa Bentley, Roger Levine, National Registry of EMTs

Background: Everyday risks inherent to emergency medical services (EMS) include exposure to infectious substances and accidents involving emergency vehicles. An additional danger faced by EMS professionals comes from the patients, their relatives, and bystanders, who in tense situations may direct their aggression toward the EMS professional as either verbal or physical assault. **Objective:** To describe the prevalence of and identify characteristics associated with violence towards EMS professionals. **Methods:** In 2013, EMT-basics and paramedics responded to the Longitudinal EMT Attributes and Demographic Study, which included fourteen items on violence

encountered either from patients or their relatives and bystanders in the past 12 months. Violence included punching, spitting, biting, verbal abuse, stabbing and shooting attempts, or objects thrown. Individuals were classified into dichotomous groups as either having experienced at least one form of violence in the past 12 months or not. Characteristics assessed included gender, volunteerism, community size, type of EMS agency, years of EMS experience, and call volume. Analyses were conducted on respondents who reported working as EMS professionals in the last 12 months. Student *t*-test and chi-square analyses were utilized ($\alpha = 0.05$). **Results:** Responses were received from 2,579/4,238 (60.8%) individuals, with 1,780 reporting having worked in EMS in the last year. Over two-thirds (68.0%) reported having experienced violence in the past 12 months. Of these individuals, 70.3% were male, 17.8% were volunteers, and 57.0% worked in urban communities (>25,000 people). Private agencies employed the highest percentage of those who experienced violence (41.5%), followed by fire departments (29.2%). The mean years of experience for EMS providers who encountered violence was 5.35 (95% CI 5.0-5.6) compared to 4.12 (95% CI 3.6-4.6) for those who did not. Mean weekly call volume was 17.7 (95% CI 16.9-18.5) for those who experienced violence compared to 8.4 (95% CI 7.5-9.2) for those who did not. All variables reported were statistically significant. **Conclusions:** More than two-thirds of EMS professionals reported having experienced some form of assault in the past 12 months. Further research is needed to identify predictors of violence by type (verbal and physical) and ways to prevent violence in the pre-hospital environment.

107. THE DEVELOPMENT OF NEW TECHNOLOGY FOR PARAMEDICS AND MEDICAL CONTROL PHYSICIANS USING QUALITATIVE ASSESSMENT

Robert Norton, Holly Jimison, Mark Yarvis, Ritu Sahni, Lenitra Durham, William Hatt, Richard Harper, Merlin Curry, Oregon Health & Science University

Background: User-centered design is critical for high-stakes applications such as emergency medical services (EMS) information technologies. It is challenging to validate requirements and test candidate features in the field without disrupting patient care. We used qualitative methods to derive new technology requirements and design recommendations by observing physicians' and paramedics' uses of various features of a prototype EMS information system in a simulation laboratory. **Methods:** We developed a research prototype with an advanced user interface that presents a holistic patient chart, including voice-input chart annotations, transmitted in real-time from field personnel to medical control physicians. We trained 6 emergency medicine physicians with online medical control experience and 13 experienced paramedics to use this prototype. We recorded observations of participants interacting with simulated cases of chest pain, blunt trauma, and cardiac arrest. Additionally, after each case we debriefed participants and conducted semi-structured group discussions. Using N6 software for qualitative analysis of the notes from the observations and interviews and a grounded theory approach to develop a coding scheme, we identified emergent themes that described both observed technology interaction issues and participants' perceptions of the value and usefulness of the potential features. **Results:** Design recommendations derived from our analysis included specific requirements for speech recognition, voice input grammar, manual data input, battery life, alarm capabilities, and attention to privacy

and legal concerns. Physicians' expectations about medical control and their preferences for receiving information from paramedics determined whether they thought the prototype would assist or hinder them in answering calls. Paramedic and physician participants anticipated a possible impact of the prototype on quality of care, efficiency, and the relationship between paramedics and medical control. They highlighted the need for system integration and uses of the additional data from the prototype. **Conclusions:** Observational studies of a prototype technology in EMS simulations helped us to identify important requirements and design recommendations. This approach enables the iterative design and feature optimization prior to field deployment in a simulated clinical environment and may provide a model for the development and testing of other new technologies in EMS and emergency medicine.

108. A QUALITATIVE STUDY ON QUEBEC PARAMEDICS' ROLE PERCEPTION AND ATTITUDES OF CYNICISM AND DISENGAGEMENT WITHIN THE CONTEXT OF NON-URGENT INTERVENTIONS

Emmanuelle Bourdon, Nicole Leduc, Collège Ahuntsic

Background: Internationally, the paramedic role has been steadily evolving, 9-1-1 calls are increasingly of a non-emergent nature, including for the elderly and chronically ill. There may be a gap between how paramedics perceive their role and actual practice. The objective was to illustrate paramedics' experience related to non-urgent calls and explore their role perception and resulting attitudes. **Methods:** Purposeful and snowball sampling strategies were used to recruit participants for individual interviews using an open-ended guide. The data analysis was performed using a mix codification approach. Initial categories came from the interview plan themes based on a model adapted from psycho-sociology of work and quality of care in the health services theories, depicting the possible relationship of role perception and attitudes of interest in paramedic practice. **Results:** Thirteen paramedics from the province of Québec, Canada were interviewed: 9 male (69.2%); work experience range 3 months to 37 years. Emerging themes included that paramedics perceive their role and the training and field of practice as being mostly oriented toward emergency response, contrary to their pervasive work reality; describing role conflict. Participants reported they were required to fill a gap in care by providing patient education, assessments, and care outside of their practice guidelines for non-urgent patients. They described an interest to play a more active role in the delivery of care to non-urgent patients. Participants described adaptive attitudes and behaviors used when required to work in a non-urgent role. Attitudes of cynicism and disengagement were described as inherent to the professional experience of a paramedic. These attitudes appeared to be intimately linked with burnout, potentially affecting quality of care despite fundamental professional intentions. **Conclusions:** In this qualitative exploration of role conflict in paramedics, it was found participants use coping mechanisms and attitudes to manage the conflicting duality of their role. Paramedics likely have an active role to play in delivery of non-urgent care. These findings contributed to a revised theoretical model of the relationship between role perception, attitudes of cynicism and disengagement, and quality of care.

109. FREQUENCY OF PERFORMANCE OF POTENTIALLY LIFE-THREATENING DELEGATED MEDICAL ACTS BY ADVANCED CARE PARAMEDICS IN A REGIONAL BASE HOSPITAL PROGRAM

Don Eby, Al Rice, Shelly McLeod, Tracy Gaunt, Southwestern Ontario Regional Base Hospital Program

Background: Paramedic competence in the performance of rarely used delegated medical acts (MDAs) with potential life-threatening complications is a concern to physicians delegating these acts. The objective of this study was to report the proportion of calls where advanced care paramedics (ACPs) performed any of the following MDAs: cardioversion, external cardiac pacing, needle thoracostomy, nasotracheal intubation, and maintenance of a central venous pressure line. **Methods:** A retrospective review was conducted of 13,424 ambulance call reports covering a two year period (April 2011-March 2013). These calls were completed by ACPs employed in 3 EMS agencies and overseen by a regional base hospital program. ACPs in their respective EMS agencies cover primarily urban areas. Data were abstracted from a regional electronic database containing 100% of calls in which delegated medical acts were performed. **Results:** Of all 13,424 calls reviewed, there were 44 cases (0.3%) of naso-tracheal intubation, 15 calls (0.1%) utilized external cardiac pacing, 5 calls (0.04%) where cardioversions was performed, 4 calls (0.03%) in which needle thoracostomy was done, and 1 call (0.007%) involving central venous line maintenance. There were 119 ACPs included in the review in 2011-2012 and 113 ACPs in 2012-2013. This represented 232 paramedic years of ACP practice. In the systems studied, assuming every ACP across the system had an equal chance of performing the act, they would perform naso-tracheal intubation (232/44) once every 5.2 years, pacing (232/15) once every 21.5 years, cardioversion (232/5) once every 46.4 years, needle thoracostomy (232/4) once every 58 years, and central line maintenance (232/1) once every 232 years they practiced as an ACP. **Conclusions:** ACPs in the regional program undertook several delegated medical acts on an infrequent basis. These acts have potential life-threatening complications. Program resources are used to train, retrain, and certify paramedics to undertake acts they will probably never perform on a patient. This calls into question the merit of this practice.

110. USE OF LIGHTS AND SIREN: IS THERE ROOM FOR IMPROVEMENT?

Fabrice Dami, Mathieu Pasquier, Pierre-Nicolas Carron, Lausanne University Hospital

Background: The objective is to analyze the use of L&S during transport to the hospital by the prehospital severity status of the patient and the time saved by the time of day of the mission. **Methods:** We searched the Public Health Services data of a Swiss state from January 1 to December 31, 2010. All primary patient transports within the state were included (24,718). The data collected were the use of L&S, patient demographics, time and duration of transport, the type of mission (trauma vs. non-trauma), and the severity of condition according to the National Advisory Committee for Aeronautics (NACA) score assigned by the paramedics and/or emergency physician. We excluded 212 transports because of missing data. **Results:** 24,506 ambulance transports met the inclusion criteria. L&S were used 4,066 times, or in 16.6% of all missions. Forty percent of these were graded NACA < 4. Overall, the mean total transport time back to hospital was 11.09 min (CI 10.84-11.34) with L&S and 12.84 min (CI 12.72-12.96) without. The difference was 1.75 min (105 sec) ($p < 0.001$). For nighttime runs alone, the mean time saved using L&S was 0.17 minutes (10.2 sec) ($p = 0.27$). **Conclusions:** The present use of L&S

seems questionable given the severity status or NACA score of transported patients. Our results should prompt the implementation of more specific regulations for L&S use during transport to the hospital, taking into consideration certain physiological criteria of the victim as well as time of day of transport.

111. ELECTRONIC PCR INTEGRATION INTO HOSPITAL RECORDS: A 1980S SOLUTION TO A 21ST-CENTURY PROBLEM

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Background: Electronic EMS patient care reports (ePCRs) have the potential to improve communication and transfer of care between prehospital and hospital providers. However, many EMS systems anecdotally report difficulty integrating ePCRs with hospital electronic health records (EHR), potentially resulting in loss of clinically important information. A national survey was conducted to characterize this problem. **Methods:** Purposive sampling was conducted of three groups: the NAEMSP Rural Affairs Committee (small, rural systems), selected cities of populations 125,000-325,000 (mid-size systems), and the Metropolitan Municipalities EMS Medical Directors Consortium ("Eagles"; large, urban systems). The survey instrument, asking about various aspects of ePCR use and integration with the hospital, was developed by the authors, pilot-tested for usability, and revised before IRB approval, conversion to Survey Monkey, and dissemination via e-mail. Simple descriptive statistics were used to analyze responses. **Results:** Responses were received from 64/111 (58%) rural, 14/25 (56%) mid-size, and 19/33 (58%) urban systems ($n = 97$; overall response rate 57%). The medical director completed the survey in 71 cases (73%), with agency directors and IT personnel completing most of the rest. Seventy-five systems (77%) use ePCRs only, 8 use written PCRs only, and 10 use a combination. Twenty-nine systems print ePCRs to hand in to ED staff, 13 manually fax printed ePCRs to the hospital, and another 26 digitally fax from the ePCR computer to the hospital. Thirty-one systems have provided hospitals with access to their databases for retrieval of ePCRs. Only six systems (five rural, one urban) can directly transmit ePCRs into the patient's hospital EHR, and no systems use regional health information exchanges to transfer ePCRs to the hospital. Of the 58 systems reporting that the ePCR is ultimately incorporated into the patient's EHR, 36 (62%) report that it is done by hospital staff manually scanning a printed copy of the ePCR. **Conclusions:** Despite the high prevalence of ePCRs in our sample, the ability to electronically integrate an ePCR directly into the patient's EHR is rare across systems of all sizes. There is an opportunity to improve EMS electronic health information exchange given the current high degree of reliance on printing/faxing and scanning ePCRs.

112. A MULTIDISCIPLINARY APPROACH TO EFFECTIVELY REDUCE THE STREAM OF AMBULANCE ABUSE

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Background: The number of public EMS ambulance services in a metropolitan area has continuously increased up to 10 percent yearly, which presents a potential shortage of EMS resources. We launched a multidisciplinary approach to improve the rise and assess its im-

pact and the degree on EMS services reduction. **Methods:** EMS authority implemented a multidisciplinary approach to slow down the annual growth of ambulance services, including 1) a new charge policy for non-emergency condition transports, 2) repeated media advocacy and en-route leaflet for charge policy of misuse at least a half year prior to launching, 3) regular interviews with the target group who overused or misused EMS ambulance in two previous years, 4) combined assessment by health, mental health, and social health-care officials to those target group, 5) provision of alternative public transport assistance for those with disability, and 6) a joint committee to regularly inspect the legitimacy of charge for every non-emergency transport in consensus process. A metropolitan public EMS provides free services for a 2.68 million population within 272 square kilometers. The number of EMS ambulance services for three years before intervention as control and that for two years after launching are compared using regression analysis for statistics. **Results:** The average annual number of EMS services before intervention was 125,038 (SD: 12,152) runs and the annual increase was 12,356 [95% CI: 10,525-14,186] runs (annual growth: 11.0%, 95% CI: 9.3-12.6%). The annual increase for the first and second years after the multidisciplinary intervention are minus 11,320 runs (minus 8.3%, $p < 0.05$), and minus 23,969 runs (minus 16.3%, $p < 0.05$), respectively, significantly less than the estimated number. Among the target overuse group, the reduction rate reaches 18.8%. Only 0.03% of EMS transports need to be charged. **Conclusions:** We demonstrate a multidisciplinary approach including target group multidimensional assessment, which may effectively ameliorate the stream of EMS ambulance abuse and the tendency toward increase.

113. UTILIZATION OF 24-HOUR ONLINE MEDICAL CONTROL: A PRELIMINARY REPORT OF CALL VOLUME AND OVERVIEW OF CONSULTATIONS

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Background: To determine and characterize the utilization of 24-hour online medical control in a large emergency medical services (EMS) system. **Methods:** We conducted a prospective observational study among all online medical control radio calls from a large EMS system over 5 weeks. In addition to written protocols, the Orange County EMS system utilizes a centralized base station (CBS) model for clarification, further orders, or assistance with medical oversight. All radio calls were reviewed for quality assurance by the office of the medical director (OMD) and data were collected for age, consultation type, physician orders given and repeated back, establishment of decision-capacity of patient or guardian for refusal, acceptance of refusal, and need for further review. **Results:** There were 172 calls made over a 39-day period (average 4.4 per day). At least one call was made every day, and a maximum of 11 calls were received in a 24-hour period. Forty-three consultations were for pediatrics, and 129 were for adults. One hundred and twelve calls (65%) were for assistance with patient refusal of transport, 28 (16%) were for additional medications, 19 (11%) were for code termination, and 13 (8%) were miscellaneous consults. Orders were given on 21 occasions and repeated back to the physician 17 times. Among the patient refusals, 37% were pediatric. It was determined by the OMD reviewer that the patient lacked proper decision-making capacity or did not have a guardian in 25% of the refusals, and among those calls 28% of the refusals were accepted by the CBS physician. In

the remaining 75% calls the reviewer determined that the patient did have appropriate decision-making capacity or a guardian, and among those calls 89% of the refusals were accepted by the CBS physician. Overall, 27 calls were flagged by OMD for quality review based on concern for medical care or educational value. **Conclusions:** Online medical control was utilized regularly throughout the day. The majority of calls were for clarification of patient refusals. These preliminary data suggest further education is warranted for establishing decision-making capacity in patients refusing transport, and call review reveals opportunities for improved quality assurance.

114. PEDIATRIC PREHOSPITAL MEDICATION DOSING ERRORS: A QUALITATIVE STUDY

John Hoyle, Rebecca Henry, Brian Mavis, Todd Chasse, Debby Sleight, William Fales, Michigan State University

Background: To identify barriers and enablers to correct pediatric prehospital drug dosing and possible solutions through a qualitative study. Pediatric prehospital dosing errors affect approximately 56,000 US children yearly. To decrease these errors barriers, enablers and potential solutions from the EMT-P standpoint need to be understood. **Methods:** We conducted a qualitative focus group (FG) study of EMT-Ps in Michigan. FGs were held at EMS agencies and a state EMS conference. Participants were identified by random number only. To protect anonymity, no identifying information was collected. FGs were led by a trained moderator. Questions focused on the drug dose delivery process, barriers and enablers to correct drug dosing, and possible solutions to decrease errors. Responses were recorded, transcribed, and coded by 2 members of the research team for themes and number of response mentions. Participants completed a pre-discussion survey on pediatric experience and agency characteristics. **Results:** FG responses reached thematic saturation after 4 groups were completed. There were a total of 35 participants. Participants' EMS agency characteristics were 26% public, 23% private not-for-profit, 49% private for-profit, 23% fire, 77% third service. All were transporting agencies. 43% of participants had been EMT-Ps > 10 years, 11% had been EMT-Ps < 1 year. 25% reported not having administered a drug dose to a child in the last 12 months. EMT-Ps who were "very comfortable" with their ability to administer a correct drug dose to infants, toddlers, school-aged, and adolescents were 5%, 7%, 10%, and 54%, respectively. FGs identified themes of difficulty in obtaining an accurate weight, infrequent pediatric encounters, infrequent pediatric training with inadequate content and practice, difficulties with drug packaging/shortages, drug bags that weren't "EMS friendly," difficulty remembering drug doses/calculations, and lack of dosing aids. Few enablers to correct dosing were mentioned. Simplification of dose delivery, an improved length-based tape for EMS, pediatric checklists, and dose cards in milliliters were given as solutions. **Conclusions:** This qualitative study identified barriers and potential solutions to reducing prehospital pediatric drug dosing errors, including improved training frequency/content as well as simplification of drug calculations and the addition of pediatric checklists.

115. THE ASSOCIATION BETWEEN PEDIATRIC FALL INJURY AND PROPERTY TYPE IN A FIRE DISTRICT OF CLACKAMAS COUNTY

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Background: Falls account for a disproportionate number of nonfatal injuries in the pediatric population. In 2005, 2.6 million fall injuries in children 0-19 years old were reported to emergency departments. Research of fall injuries has traditionally focused on individual factors. Recent research into injury has shown associations with environmental factors, such as higher rates of poverty and smaller household size. **Objective:** To identify characteristics of the environment associated with pediatric fall injury within a fire district in Oregon. **Methods:** This case-control study included children 17 years old and under, who utilized the emergency medical services (EMS) system within Clackamas Fire District #1, Oregon, from 2009 to 2012. Cases were defined as falls and controls defined as medical illness calls. Predictor variables were selected from individual and census tract-level characteristics, with location of injury as the predictor of interest. Location of injury was categorized as either residential or non-residential. We used a multivariate logistic model to characterize the association between fall injuries and location of injury. Location addresses were geocoded to state plane coordinates. We then created a Poisson regression to determine census tract environmental factors associated with falls. **Results:** There were 526 incidents analyzed. Pediatric fall injuries had a significantly decreased odds of occurring at residential locations (OR = 0.26, 95% CI: 0.17-0.39, $p < 0.0001$) compared to non-residential locations. Controlling for case status, census tracts had a 6% (95% CI: 1.03-1.09, $p < 0.001$) increase in pediatric fall rate for every percentage that single mother families increased. For every 2 miles traveled eastward, the rate of pediatric falls increased by 11% (95% CI: 1.01-1.23, $p = 0.028$), after adjusting for case status. **Conclusions:** The results of this study suggest that environmental factors may have an effect on the likelihood of pediatric falls. Environmental data are not correlated with individuals and ecologic fallacy may be a limitation of this study. This analysis could be linked with hospital admission data to improve representation of individual children. From these data, targeted interventions may be developed to reduce the risk and degree of pediatric fall injuries.

116. A NOVEL APPROACH UTILIZING EMERGENCY MEDICAL DISPATCHERS TO OBTAIN WEIGHTS FOR PEDIATRIC PATIENTS

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Background: Pediatric drug dosing errors by paramedics are highly prevalent. An accurate weight is the first step in accurate dosing. To date, the ability of emergency medical dispatchers (EMD) to obtain patient weight has not been evaluated. We hypothesized that EMD could obtain accurate pediatric weights. **Methods:** We conducted a convenience sample of patients < 18 years old transported to a children's hospital between 4/9/12 and 5/1/13. EMD were instructed to ask the caller's relationship to the patient and the patient's weight. Paramedics completed a questionnaire including their estimate of the patient's weight. Probabilistic matching was used to match the EMD weight (EW) with the paramedic weight estimate (PW) and hospital weight (HW). **Results:** 264/2,390 (11.0%) patients had all three weights recorded. EMD recorded a caller relationship in 197 of the 264 (parent/guardian 133, other family 17, non-family 47). Patients were grouped by age: 0-5 years (132 patients), 6-11 years (48 patients), and 12-17 years (84 patients). The Wilcoxon test was used to compare EW and PW to HW for each subgroup. For 0-5 years, the mean difference between EW and HW was -0.09 kg (95%CI -1.09 to 0.91), $p = 0.736$. The

mean difference between PW and HW was -0.06 kg (95%CI -0.50 to 0.39), $p = 0.465$. For 6-11 years, the mean difference between EW and HW was 1.90 kg (95%CI -0.41 to 4.21), $p = 0.047$. The mean difference between PW and HW was 1.49 kg (95%CI -0.31 to 3.29), $p = 0.086$. For 12-17 years the mean difference between EW and HW was 3.46 kg (95%CI 1.07 to 5.85), $p = 0.030$. The mean difference between PW and HW was 2.81 kg (95%CI 0.27 to 5.36), $p = 0.002$. **Conclusions:** EMD were able to obtain accurate weights for the pediatric patients aged 0-5 years. Paramedic weight estimations for 0-5 and 6-11 year olds were accurate. Further investigation is needed to see how EMD collection of weight can be improved and if communication of this information to paramedics can reduce dosing errors.

117. REPORTED BARRIERS AND ENABLERS TO PEDIATRIC VITAL SIGN ASSESSMENT BY PREHOSPITAL PROVIDERS

Kathleen Adelgais, Lara Rappaport, Kevin Waters, Jason Kotas, Maria Mandt, Aurora Fire Department, University of Colorado

Background: Prehospital providers (PHPs) report a low likelihood of obtaining VS in their pediatric patients and studies demonstrate incomplete vital sign (VS) monitoring in children. Our objective was to identify barriers and enablers to pediatric VS assessment among PHPs. **Methods:** We performed a previously validated survey of PHPs with stratified sampling by EMS provider type and practice location. Participants were asked to indicate on a 5-point Likert scale (1 = strongly disagree to 5 = strongly agree) their agreement with answers for the following: "I believe that (blank) is a BARRIER to obtaining VS" and "The BEST way to encourage prehospital pediatric VS assessment is (blank)." Each statement had a series of choices with a free text option. Barriers were grouped into general prehospital care factors and those inherent to nature of the pediatric patient. Enablers were grouped into extrinsic factors, such as mandates, and intrinsic factors, such as internal motivators. **Results:** We had a total of 253 respondents (response rate 25.3%). Respondents were similar to non-respondents with regard to practice locale and EMS provider type. Median age was 40 years (IQR 30, 49), median years of practice was 7 (IQR 3, 15.75), with 61.3% in an urban/suburban location. Respondents most commonly reported factors inherent to the patient as barriers to VS assessment, with a rating of >3 ("Agree") for the following: compliance (60.9%), irritating the patient (65.0%), and low pediatric call volume (62.5%). General prehospital care factors such as transport time, multitasking, and lack of equipment were not strongly identified as barriers with a median of 2 ("Somewhat Disagree") for each item. Respondents identified intrinsic factors as the best enablers with a response of "Strongly Agree, 5" for all the following: education, feedback on patient outcome, and increased practice. Extrinsic factors, such as mandates, incentives, and direct download from monitors, were not as strongly supported ("Somewhat Disagree"). **Conclusions:** PHPs report few barriers to obtaining VS in children, all relating to the intrinsic nature of caring for the pediatric patient. Increased education, feedback, and practice were all identified as factors that would likely impact their likelihood of assessing VS in children.

118. PEDIATRIC PATIENTS WITH EXPOSURES RARELY NEED ADVANCED LIFE SUPPORT PREHOSPITAL CARE

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Background: Pediatric exposures result in frequent calls to poison control centers and referrals to emergency departments. Despite the frequency, little is written in prehospital literature about the interventions performed on pediatric patient requiring advanced life support (ALS) for toxic exposures. We sought to characterize the prevalence and types of interventions performed by ALS on pediatric patients with exposures. Setting: A large, suburban, two-tiered EMS system with approximately 27,000 advanced life support (ALS) requests per year. Design: Retrospective cohort study. Population: Consecutive patients less than 13 years old for which ALS was requested for the dispatch categories of "Ingestion" or "Overdose" over a 66-month period. Calls primarily for allergic reactions that were misclassified were excluded. Initial Glasgow Coma Score (GCS), procedures performed, and medications given were recorded. Placement of an intravenous line (IV) was considered a procedure, but normal saline was not considered a medication. Descriptive data with percentages and 95% confidence intervals (CI) were calculated. **Results:** Of 103,289 total ALS calls, 39 (0.04%) were for pediatric exposures. The average age of the patients was 3.0 years (CI: 2.4, 3.6). The average initial GCS was 14.6 (CI: 14.1, 15.1), with only 3 patients having a GCS less than 15. 10% of patients (CI: 1, 20) had peripheral IVs attempted, and no other procedures were performed. No patients were given a medication. One patient, a 10-year-old with a clonidine and guaifenesin ingestion, had an IV and naloxone ordered, but naloxone was not given because the IV could not be established. **Conclusions:** Despite the frequency of calls to poison control centers for pediatric exposures, very few, if any, of calls classified as "Ingestion" or "Overdose" in children less than 13 years old require prehospital ALS interventions. This information may be useful in making dispatch decisions.

119. IMPACT OF PEPP AND PALS TRAINING ON BELIEFS AROUND IMPORTANCE OF PEDIATRIC VITAL SIGNS AMONG PREHOSPITAL PROVIDERS

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

Background: Historically, prehospital providers (PHPs) have reported a lower likelihood of obtaining pediatric vital signs (VS). Despite Pediatric Education for the Prehospital Professional (PEPP) training and incorporating the Pediatric Assessment Triangle (PAT) into Pediatric Advanced Life Support (PALS), disparities still exist in pediatric VS assessment by PHPs. We examined the impact of reported PEPP and PALS training on beliefs surrounding pediatric VS assessment among PHPs. **Methods:** We surveyed a statewide sample of PHPs stratified by EMS provider type and practice location. Survey content was created with subject matter experts to ascertain perceptions around pediatric VS assessment. We examined associations between survey responses and prior PEPP/PALS training using univariate analysis. We used a 5-point Likert scale to assess strength of agreement with certain responses. We identified which VS were considered necessary and clinical scenarios in which VS were reported to be important. **Results:** The 253 respondents (response rate 25.3%) were similar to non-respondents with regard to provider type and locale. Median years of practice was 7 (IQR 3, 15.75), 61.3% in urban/suburban agencies. Prior PEPP and PALS training were 61.3% and 44.7%, respectively. Compared to those without, those with training indicated they routinely obtain VS (OR 7.0 95% CI 2.88, 17.3) and were

familiar with the PAT (OR 2.7, 95% CI 1.3, 5.9). PALS training was associated with reports of knowing VS norms (OR 2.7, 95% OR 1.2, 4.5). Independent of training, the majority agreed that interventions may often be needed based on VS (75.7%), and the PAT should not replace VS (68.5%). When stratifying by individual VS, those with either training were more likely to report that assessment of heart rate (92.9% vs. 77.2%), respiratory rate (92.4% vs. 70.2%), and capillary refill (73.5% vs. 49.1%) were necessary in all patients. Overall, only 65.6% reported that a BP was necessary. Independent of training, respondents strongly agreed that VS measurements were necessary for patients in most clinical situations excluding psychiatric emergencies. **Conclusions:** PHPs recognize the importance of pediatric VS measurement. PHPs with PEPP/PALS training are more likely to report assessment of VS in all patients. Only PALS training increased reported knowledge of VS norms.

120. BYSTANDER CPR AND HOSPITAL OUTCOMES AFTER PEDIATRIC OUT-OF-HOSPITAL CARDIAC ARREST BY PRESUMED ETIOLOGY: A NATIONWIDE OBSERVATIONAL STUDY

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Background: Pediatric out-of-hospital cardiac arrest (OHCA) is known to have different etiology, outcomes, and bystander cardiopulmonary resuscitation (B-CPR) protocol compared with that of adults. However, it is unclear whether B-CPR has an interaction with etiology of OHCA for outcomes or not. The study aims to determine the association between bystander CPR by etiology group and survival to discharge after pediatric OHCA. **Methods:** Pediatric (<19 years old) patients transported by emergency medical services were collected from nationwide cardiac registry between 2008 and 2012, excluding patients with unknown outcome. Variables included age, gender, place, witness, B-CPR, metropolitan versus non-metropolitan, response time, defibrillation by ambulance providers, levels of emergency department, primary ECG group, and etiology. Etiology was classified as presumed cardiac, trauma, drowning, asphyxia, and others. Primary and secondary outcomes were survival to discharge and good neurological recovery. Multivariable logistic regression analyses were performed, adjusting for potential confounders without considering interaction terms between B-CPR and etiology groups (simple model) and considering interaction term (interaction model) to calculate adjusted odds ratios (AORs) and 95% confidence intervals (CIs). **Results:** Of 112,895 EMS-assessed OHCA, 3,488 patients (3.8%) were analyzed (male 63.9%, median age 8.3). The survival to discharge and good neurological recovery was 5.7% (22.9% in B-CPR and 4.9% in non-B-CPR) and 2.3% (11.9% in B-CPR group and 1.8% in non-B-CPR), respectively. B-CPR was performed in 6.2% for total patients, 8.7% in cardiac group (n = 1,645), 1.5% in trauma group (n = 1,046), 6.9% in drowning (n = 276), 8.3% in asphyxia (n = 348), and 1.7% in others (n = 173), respectively (p < 0.001). A simple model for survival to discharge showed a significant association between B-CPR and outcomes: AOR 4.29 (95% CI 3.24-7.19) for survival to discharge and AOR 5.32 (95% CI 3.08-9.20), respectively. In an interaction model for survival to discharge, AORs (95% CIs) of B-CPR and interaction effect with cardiac, trauma, drowning, asphyxia, and others were 4.68 (2.92-7.49), 4.84 (3.25-7.21), 5.01 (3.06-8.22), 5.19 (2.60-

10.36), and 5.97 (1.09-32.62), respectively. In interaction model for good neurological recovery, AORs (95% CIs) of B-CPR and interaction effect with cardiac, trauma, drowning, asphyxia, and other groups were all significantly higher than 1.0. **Conclusions:** There was significant association between bystander CPR and improved outcomes without any significant interaction effect with presumed etiology groups in pediatric OHCA.

121. FIELD TRIAGE PROTOCOL FOR BEHAVIORAL HEALTH PATIENTS

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Background: Mental illness represents the second largest disease burden in the United States. While the gross number of annual emergency department (ED) visits has remained relatively stable, the proportion of patients presenting with psychiatric complaints continues to increase. Furthermore, psychiatric patients are more likely to be frequent EMS and ED users than non-psychiatric patients. In this review of prospectively collected data, we evaluate the efficacy of a field triage protocol implemented by EMS providers to divert behavioral health patients from the EDs directly to a psychiatric facility. **Methods:** A triage protocol was designed for use by EMS personnel to identify behavioral health patients who can safely be transported directly to a psychiatric facility without medical evaluation in an emergency department. Exclusion criteria included age <18, temperature > 38.0°C, HR > 130, SBP < 100, RR < 10, aggressive/dangerous behavior, significant comorbidities, known drug overdose, and acute drug or alcohol intoxication. Patients without any exclusion criteria were transported by EMS directly to a psychiatric evaluation center. Data were collected prospectively during 12-month periods before and after initiation of the protocol. Primary outcome was number of patients taken by EMS to the ED for behavioral health complaints. **Results:** In total, 125 patients were triaged directly to a psychiatric facility using the protocol. Prior to initiation of the triage protocol, an average 92 patients/month were taken to area EDs for evaluation. In the period following implementation, on average 16 patients per month (18%) with EMS behavioral health transfers were directly triaged to a psychiatric facility, bypassing area EDs. Eight patients (6.4%) were subsequently transferred to an ED for medical clearance. All of these patients were returned to the psychiatric facility for admission following ED evaluation. Of the 125 patients directly transported to the psychiatric facility, there were no adverse outcomes. **Conclusions:** Use of a behavioral health triage protocol can be safely implemented in the prehospital setting. Use of such protocol appears to decrease ED behavioral health patient volume and may allow for more appropriate utilization of the health-care system. One limitation of the study was that we were unable to calculate the number of patients who were transported to the ED despite qualifying for the protocol.

122. IS A SUCCESSFUL ADVANCED LIFE SUPPORT PARAMEDIC CERTIFICATION EXAMINATION USING OSCE METHODOLOGY A PREDICTOR OF AUTONOMOUS PRACTICE CONSISTENT WITH CLINICAL MEDICAL DIRECTIVES AND GUIDELINES?

Maud Huiskamp, Leah Watson, Linda Turner, Sunnybrook Centre for Prehospital Care

Background: Widely used in other health professions but often unevaluated, objectively structured clinical examination (OSCE)

methodology using simulated patient encounters is uncommon in paramedicine. In our system, passage of an OSCE is required for advanced care life support (ALS-EMS) certification. **Objective:** To determine whether the number of attempts required to successfully complete an OSCE was associated with subsequent autonomous practice consistent with medical directives and whether consistency increased with time. **Methods:** The setting was 4 urban paramedic services (population, approximately 8 million). Examination comprised 15 components assessing competence in communication, patient assessment, judgment, and clinical procedures. Judgment of subsequent clinical practice was based on review of ambulance call reports (ACRs) electronically triaged through an algorithm to identify areas of potential variance from medical directives. Identified cases were peer reviewed. Variances judged to have occurred were graded as minor, major, or critical. The number of major or critical variances per 100 high-acuity calls (Canadian Triage and Acuity Scale level 1 or 2) that each successful candidate had attended within 2 years following certification was calculated. Variance rates (<1 vs. ≥1) were compared with the number of attempts required to successfully complete the OSCE. We also tabulated number of variances (0 vs. ≥1) during each 6-month period. **Results:** From March 2010 through October 2012, 83/109 (76.1%) candidates were successful, 66 on the first attempt. Candidates successful on the first attempt were less likely to have a variance rate ≥ 1 compared with candidates requiring 2 or 3 attempts (58.5% vs. 82.4%, respectively) (Fisher exact test, P = 0.058). For candidates with at least 2 years of practice following completion of the OSCE, the proportion for whom no variances were detected increased somewhat: 65.6% (21/32) in the 1st 6-month period to 78.1% (25/32) in the 4th (chi-square test, P = 0.27). **Conclusions:** We found evidence that higher performance on an OSCE predicted practice more consistent with medical directives. A limitation is that judgments of practice were based on reviews of ACRs completed by the attending paramedic rather than direct observation. Further research is needed to generalize these results to other systems.

123. THE EFFECT AND SATISFACTION LEVEL OF AN OUT-OF-HOSPITAL DELIVERY AND NEONATAL CARE EDUCATION PROGRAM OF EMERGENCY MEDICAL SERVICE PROVIDERS

Won Pyo Hong, Joong Eui Rhee, Kyonghee Noh, Yu Jin Kim, Joon-Seok Hong, Kwang Hee Park, Joo Jeong, Seogwipo Medical Center

Background: Emergency medical service (EMS) providers often care for pregnant women at risk for out-of-hospital delivery and born-before-arrival neonate. The mortality and morbidity of out-of-hospital delivery is well established. This study was done to determine if there was some effect of a delivery and neonatal care education program on the knowledge and practice of EMS providers. **Methods:** The EMS providers working in the southeast Gyeonggi province in South Korea participated in an education program of out-of-hospital delivery and neonatal care. The program consisted of pretest, didactic, manikin training, post-test. Six months after the education, a follow-up survey was administered. A paired t-test was used to compare pretest and post-test scores. **Results:** The study was completed by 56 EMS providers. The pretest average score was 80.4 and the post-test average score was 92.9 (p < 0.001). The percentage of correct answers on each question elevated relatively equally in the post-test regardless certification. Participants

expressed satisfaction with the education program. This appraisal was maintained in the 6-month follow-up survey. **Conclusions:** These results suggest that EMS providers can learn information regarding the out-of-hospital delivery and neonatal care after a didactic and training session. Further study is needed to develop the reliability and validity of the test and to determine how this information is clinically applicable.

124. PERCEPTION AND COST OF A PREHOSPITAL PROVIDER PROCEDURE WORKSHOP UTILIZING CADAVERS

Thomas Hartka, Mark Sochor, Sara Heltzel, University of Virginia

Background: EMTs and paramedics may be called on to execute a number of procedures in the field that are infrequently performed. Cadavers serve as realistic models on which to teach and practice these medical procedures. **Methods:** A half-day workshop was developed in order to train local EMS personnel in medical procedures utilizing cadavers and trainer manikins. Medical procedures included intubation, needle decompression, chest tube placement, suturing, intrasosseous needle placement, and thoracotomy. The course was taught by an attending physician, two emergency medicine residents, and a Certified Surgical Technologist (CST). Two structured 45-minute lectures were presented, followed by two 2-hour blocks in which participants performed procedures on either simulated trainer manikins or cadavers. Participants were asked to complete an anonymous questionnaire evaluating the course on a 5-point Likert scale (1 = poor, 5 = superior). Each section of the course was evaluated and an overall of assessment of the course was obtained. The cadaver course was approved by an oversight committee and all specimens were screened for communicable diseases. **Results:** Since 2012, 35 participants have attended three course offerings of this workshop. The mean overall evaluation of the course was 4.8 out of 5. The mean score for the trainer manikin section was 4.6, while all participants gave a superior response (Likert = 5) to the cadaveric portion of the workshop. The costs of two cadavers for each course totaled \$6,000 and included fees for acquisition, serology, storage, and disposal. The physician instructors and CST volunteered time to the workshop, while expired supplies were obtained free of charge from the local teaching hospital. The approximate cost per participant was \$300; however, participants paid \$200 per workshop to help defray expenses. **Conclusions:** This procedure workshop provided a unique opportunity for EMS personnel to train on infrequent, but highly technical skills. The cadaveric portion of workshop unanimously received the highest possible evaluation scores, yet all aspects of the workshop were well received, suggesting a potential for continuation and expansion of the instruction in the future. The cost of the workshop and time commitment of instructors is substantial; therefore, additional research is needed.

125. EQUIVALENT CERTIFICATION RATES AND TEST PERFORMANCE OF STUDENTS IN AN ONLINE VS. TRADITIONAL CLASSROOM PARAMEDIC TRAINING PROGRAM

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Background: There is some evidence to suggest that digital learning or Web-based education may be an effective alternative to more

traditional training. Few studies have compared the education outcomes of the traditional classroom training vs. online learning in EMS. **Objective:** To compare the performance of paramedic students in traditional classroom training program vs. an online training programs with respect to standardized assessments and pass rates on exams. **Methods:** This is an observational cohort study of paramedic students at one EMS training center offering two different forms of training (traditional and online). The traditional paramedic program is taught through a conventional classroom experience. Alternatively, the center offers a digital classroom using a combination of Web-based classes, asynchronous experience, and skill sessions. Students enrolled in the format of their choice. Two particular exams were compared: the certification exam and the Health Education Systems, Inc. (HESI) exit exams. Results from these exams were used to compare the educational outcomes of traditional vs. digital learners. Data were entered into Microsoft Excel 2010 (Redmond, WA). Means, standard deviations, proportions, and confidence intervals were calculated. In addition, t-test and Fisher's exact test were performed to compare groups using SPSS 21.0 (Armonk, NY). **Results:** A total of 27 traditional students and 77 digital students enrolled in the program. The mean age of traditional students was 26.9 ± SD5.4 vs. 34.0 ± SD 8.5 for digital learners (p < 0.001). The mean HESI of traditional students was 626 ± SD97 vs. 690 ± SD 114 for digital learners (p = 0.007). The certification rate was 100% in both groups for student completing the training. The course completion rate of traditional students was 85% (CI 72-99) vs. 84% (CI 76-93) for digital learners (p = 1.00). **Conclusions:** Digital learners performed at least as well as traditional learners on certification and knowledge exams. Larger, randomized studies need to be undertaken to understand the role of digital learning in EMS education and clinical performance.

126. EXPERIENTIAL AND RATIONAL CLINICAL DECISION-MAKING: A SURVEY TO DETERMINE DECISION-MAKING STYLES OF PARAMEDIC STUDENTS

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Background: Decisions are made using experiential (intuitive) or rational (conscious and deliberate) thinking. A previous study found ground ambulance paramedics have greater affinity for rational over experiential thinking. The thinking style of paramedic trainees is unknown. This study looked at paramedic students' preference toward and perceived ability to use experiential and rational thinking. **Methods:** Primary care paramedic students at entry to practice level from training programs in New Brunswick, Nova Scotia, and Ontario, Canada voluntarily completed the Rational Experiential Inventory-40, a 40-question validated psychometric survey-based tool. Twenty questions evaluated each thinking style, of which ten assessed preference toward and ten assessed ability to use that style. Questions were scored on a five-point Likert scale. Higher scores indicated higher affinity for that style. Analysis included descriptive statistics and t-tests to determine differences in overall thinking style scores, preference toward, and ability to use each style. Differences in thinking styles within demographic variables were evaluated with t-tests and ANOVA. **Results:** The response rate was 84.8% (273/322). Most participants were male (n = 179, 63.4%), training in Ontario (n = 204, 76.1%), completed high school or an undergraduate degree prior to paramedic train-

ing (n = 85, 31.7%; n = 68, 25.4%), and median age was 23 years (IQR 21-26). Mean score for rational thinking was 3.97/5 (95%CI 3.92-4.02) compared to 3.35/5 (95%CI 3.30-3.41) for experiential thinking (p < 0.001). Participants scored their ability to use rational thinking higher than experiential thinking: 4.03/5 (95%CI 3.97-4.08) vs. 3.55/5 (95%CI 3.50-3.61), p < 0.001, and preferred rational over experiential thinking: 3.90/5 (95%CI 3.85-3.97) vs. 3.16/5 (95% CI 3.09-3.22), p < 0.001. Higher rational scores were given by younger paramedic students (p = 0.04) and students with more prior education (p < 0.01) compared to their colleagues. **Conclusions:** Paramedic students prefer and perceive themselves able to use rational over experiential thinking, similar to findings from working paramedic, emergency physician, and cardiologist samples, but contrasting with college students who scored experiential thinking higher. This study adds to what is known about paramedic decision-making. It is important for paramedic educators and mentors to understand how paramedic students tend to process decisions. Future research includes identifying how to assess decision-making in training and determining which thinking style is best for particular clinical conditions.

127. A NOVEL SIMULATION-BASED EDUCATIONAL PROGRAM FOR ADVANCED EMERGENCY MEDICAL SERVICES PROVIDERS

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Background: Simulation-based training is commonly used and shown to be effective for medical and nursing providers of various levels of training, with fewer data available on simulation-based training programs designed by and for paramedics. We aimed to determine whether a simulation-based educational program designed and implemented by paramedics can lead to changes in performance of key interventions by paramedics managing respiratory emergencies. **Methods:** We retrospectively reviewed a quality improvement database containing data from 517 respiratory emergency cases from one large urban EMS service. We reviewed the medical care provided in cases that had any one of the following: Glasgow Coma Scale less than 15, pulse oximetry less than 90%, respiratory rate greater than 24 bpm, or heart rate greater than 100 bpm (n = 481). The primary outcomes included the proportion of cases receiving key airway interventions or specific protocol-appropriate medications before and after the delivery of the training program. We also report the results of a post-instruction satisfaction survey. Primary outcomes were compared with Pearson's chi-squared test for airway interventions and two-tailed Student's t-test for mean number of medication interventions. **Results:** Of the 481 cases, 46 (10%) had an airway intervention and 103 (21%) had a medication administration. There was a significant increase in the mean number of protocol-based medication administrations before and after the training program (0.196 vs. 0.353, p = 0.0091). There was no significant difference in the proportion of cases with an airway intervention performed (8.5% vs. 10%, p = 0.58). Providers rated the session as excellent (70%) or good (30%), plan to use the information that they learned (100%), and plan to attend similarly designed future educational sessions (90%). **Conclusions:** We identified an increased number of protocol-appropriate medications administered to prehospital patients with respiratory emergencies after delivery of a simulation-based training program designed and implemented by paramedics. This suggests

that such programs can lead to changes in paramedic practice and paramedics were satisfied with the intervention.

128. DID PARAMEDICS LEARN IN CME?

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Background: The Kolb experimental learning design identifies four distinct learning styles, which coincide with a four-staged learning cycle. The Kolb method includes learners feeling, watching, thinking, and doing. The Regional Paramedic Program for Eastern Ontario is mandated to provide medical oversight inclusive of Continuing Medical Education (CME) to nine paramedic service operators in Southeastern Ontario. Our goal was to evaluate the Kolb experimental learning model after implementation at our CME. **Methods:** The CME session was planned, designed, and implemented utilizing the Kolb model. Facilitators were introduced to the learning objectives and desired outcomes prior to the CME sessions and delivered the objectives to the learners (paramedics) during the CME day. Anonymous pre learning (session) and post learning (session) multiple choice questionnaires were administered to the paramedics. The questions directly related to a deliverable (learning objective) within the CME sessions. Using an observational study, we measured the change (increase or decrease) in learning by pairing up pre and post for each paramedic and noting the results. **Results:** 712 paramedics participated in Spring CME. 492 paramedics completed pre and post questionnaires. 157 (32%) respondents were ACP, 335 (68%) respondents were PCP. Mean knowledge increase range for 157 ACPs: 12.1% to 32.1% (confidence interval [CI] 95%). Median range for 157 ACPs: 3.9% to 20.0%. Mean knowledge increase range for 335 PCPs: 18.0% to 27.3% (confidence interval [CI] 95%). Median range for 335 PCPs: 13.4% to 26.7%. The results demonstrate a marked increase in paramedic learning after leaving the CME session, two-tailed p value is <0.0001 and one-tailed p value is 0.0002. There was evidence that suggested that participant satisfaction scores did not correlate with paramedics overall learning. **Conclusions:** Utilizing Kolb's experiential learning design model for adult learners, paramedics did increase their learning in their classroom continuing medical education session.

129. FEWER PRECEPTORS LEADS TO FASTER ATTAINMENT OF TEAM LEADERSHIP COMPETENCY DURING PARAMEDIC STUDENT INTERNSHIPS

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Background: Previous research has shown that limiting the number of preceptors a paramedic student (PS) works with during field internships results in greater opportunity to serve as a team leader and greater overall number of successful leads. This project sought to investigate if limiting PS preceptors led to attainment of competency sooner. Exposing paramedic students to fewer preceptors during field internship results in a more rapid attainment of team leadership competency. **Methods:** During field internships PS's and their preceptors involved in the National Registry of EMTs Paramedic Psychomotor Competency Portfolio Package Project (NRPPCPP) evaluated team leadership (TL) performance after each patient encounter. Terminal TL competency was arbitrarily set as 90% success rate over 20 attempts (Eureka). Verified TL performances documented in FISDAP® (Headwaters Software Inc., St. Paul

MN) were reviewed. Data were analyzed using a regression model with total number of runs and runs required to reach Eureka as covariates. **Results:** Records from 439 PS's were evaluated with 275 (63%) reaching Eureka. Average number of runs was similar (range 62.2-69.2) when 1%-59% of runs were completed with the same preceptor (PRC). When PRC was 90-100%, students reached Eureka in an average of 35.2 runs. Controlling for total run count (included as covariate in the regression model) for every 1% increase in runs with the same preceptor, the Eureka run number decreases by 0.4 ($p < 0.001$). **Conclusions:** Exposing PS to fewer preceptors during field internship results in a more rapid attainment of team leadership competency.

130. LEARNING STYLE PREFERENCES AND CONTINUING MEDICAL EDUCATION ACTIVITIES OF NOVA SCOTIA PARAMEDICS: A PILOT STUDY

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Background: Paramedics participate in continuing medical education (CME) to maintain their skills and knowledge. It is important for participants to understand their learning style for education to be most effective. This study identifies the preferred learning styles of ground ambulance paramedics, describes the elective CME opportunities paramedics attend, and examined associations between learning style and types of CME attended. **Methods:** Paramedics were invited to participate in a voluntary online questionnaire containing the Kolb Learning Style Inventory and a CME activity survey. CME activities were categorized into the four learning styles. Results were reported descriptively. Associations between demographic variables and learning style were assessed with ANOVA and chi-squared test, and association between learning style and CME categories attended were tested with ANOVA, with $p < 0.05$ considered significant. **Results:** 260 paramedics participated. The medium age was 36 (range 20-63). 38% were female ($n = 92$). Most had college ($n = 146$, 68%) or university education ($n = 68$, 32%). Half had 10 or fewer years of EMS experience ($n = 129$, 53%). Preferred learning styles were assimilator ($n = 72$, 28%), diverger ($n = 66$, 25%), converger ($n = 62$, 24%), and accommodator ($n = 60$, 23%). More advanced life support providers ($n = 131$, 54%) were assimilators ($n = 45$, 36%), and more basic life support providers ($n = 111$, 46%) were divergers ($n = 33$, 43%) (chi-squared, $p = NS$). Significant associations were not found between learning style and previous education or years of experience. The types of CME activities attended were assimilating (e.g., lectures) 25%, diverging (e.g., scenarios) 26%, converging (e.g., formal testing) 25%, and accommodating (e.g., job shadowing) 24%. No significant association was found between learning style and type of CME attended. **Conclusions:** This even distribution of learning styles suggests paramedics are a diverse group of learners. Paramedics attend a wide variety of types of CME activities. Paramedics may be able to select CME activities that better match their style to improve learning efficiency. Organizations providing education opportunities to paramedics should consider paramedics a diverse learning group when designing their programs.

131. A QUANTITATIVE ANALYSIS OF THE CONTENT OF CRITICAL PATIENT HANDOVERS BETWEEN EMERGENCY MEDICAL SERVICE AND EMERGENCY DEPARTMENT PROVIDERS

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Background: Patient handovers are an integral component of quality patient care, yet are increasingly identified as a potential source of medical error. Studies have demonstrated the benefits of standardized handovers in decreasing morbidity, particularly in critical patients. While much work has been done on improving handovers in the hospital setting, data on handovers from emergency medical services (EMS) providers are limited. Further, to our knowledge there has yet been no quantitative analysis of the content of EMS provider handovers. We here present a quantitative analysis of the content of handovers from EMS providers to emergency department (ED) physicians. **Methods:** Handovers from EMS to ED providers in the resuscitation bay of our academic level II trauma center were recorded from April to July 2013. Handovers occurring during daytime weekday hours were audio recorded by a trained research assistant. Pediatric and non-critical patients were excluded, as were handovers to non-physician providers. Recordings were coded on a standardized form by physicians trained in EMS and entered into a spreadsheet for analysis. **Results:** A total of 97 handovers were recorded during the study period, 82.6% 9-1-1 transports and 8.1% interfacility transfers. 38% were performed by EMTs while 62% were performed by paramedics. 78% of handovers reported a chief concern, 57.7% contained a scene description, 56.7% contained patient vital signs, 47.4% contained a physical examination, 31.9% included a past medical history, and 6.2% included an allergy history. 30.9% of providers included an overall assessment. Significantly more paramedic handovers included vital signs (70% vs. 37%, $\chi^2 = 12.5$, $p < 0.01$) and a physical exam (63% vs. 23%, $\chi^2 = 14.8$, $p < 0.01$). Paramedics provided more past medical histories (38% vs. 17%, $\chi^2 = 4.8$, $p = 0.09$), although this did not reach statistical significance. **Conclusions:** To our knowledge, this is the first quantitative analysis of the content of patient handovers between EMS and ED providers. While previous studies have demonstrated that EMS providers feel they generally provide adequate handovers, we identified substantial deficiencies in the quantity of information transferred. Our analysis demonstrates the need for further training in the provision of patient handovers, particularly at the EMT level. Such a program is currently under development in our EMS system.

132. STANDARDIZING PATIENT HANDOVERS IN PARAMEDIC EDUCATION IMPROVES COMMUNICATION

Andrew Stevens, Joe Turner, Megan Soultz, Leon Bell, Dylan Cooper, Indiana University

Background: Emergency medical services (EMS) patient handoffs are a critical step in patient care and safety in the emergency department. In the United States approximately 28 million such handoffs occur every year with no formal patient handover curriculum in accredited paramedic science education. New South Wales (NSW), Australia utilizes a formal method of the minimum information needed to effectively transition prehospital patient care, the IMIST-AMBO Model (identification, mechanism/medical complaint, injuries/information relative to complaint, signs/vitals, including GCS, treatment and trends, allergies, medications, background history, and other pertinent information). The aim of our study was to implement the NSW model in addition to a traditional paramedic sciences student curriculum and comparatively test communication prospectively in a simulation lab versus classroom environment. **Methods:** The study took place

at a large urban academic medical center. Participants were unaware of the study and investigators were blinded. Paramedic science students were equally randomized into two groups. Students in the experimental group received a 1-hour formal lecture on patient handovers including the IMIST-AMBO method during their ambulance operations course curriculum. Control students received the normal accredited curriculum without additional handoff training. Both student groups were presented with the same adult trauma case for handover. Student communication skills were tested by one of two methods: interprofessional high-fidelity simulation or classroom-based tabletop exercises. Students were randomized equally into testing methods and interactions were video-recorded and data collected by independent reviewers using standardized collection forms. **Results:** We studied 24 paramedic students on the 9-item scale. Control group students appropriately communicated an average of 6.33 items correctly (SD 1.4). Experimental group students appropriately communicated an average of 7.5 items correctly (SD 1.4). Comparing testing methods for all groups, high-fidelity simulation averaged 6 items communicated versus classroom tabletop exercise of 7.83. **Conclusions:** A structured patient handover communication model for paramedic science students can increase appropriate handoff information items. Additionally, we observed more difficulty communicating these items in the high-fidelity simulated working environment when compared to classical classroom tabletop role playing. This model may provide future direction in prehospital communication curriculum development.

133. AN EDUCATIONAL MEASURE TO SIGNIFICANTLY INCREASE CRITICAL KNOWLEDGE REGARDING INTER-FACILITY PATIENT TRANSFERS (EMS-SICK-PT)

Torben Becker, James Skiba, Cemal Sozener, University of Michigan

Background: Emergency medicine residents and critical care fellows have only limited educational exposure to the challenges of inter-facility patient transfers, which includes legal considerations (such as EMTALA), knowledge of particularities of the local EMS systems (equipment, provider qualification, protocols), and adequate communication with prehospital providers and the involved physicians at the receiving facility. A one-hour educational intervention will significantly increase the knowledge of emergency medicine residents and critical care fellows of the different medical and legal aspects of inter-facility patient transfer. **Methods:** Emergency medicine residents and critical care fellows (surgery, internal medicine, anesthesiology, and pediatric critical care programs) at a tertiary care academic medical center participated in an hour-long lecture/interactive instruction on the medical and legal aspects of inter-facility patient transfers. This was followed by a discussion of case-based scenarios. Prior to the educational intervention, participants filled out a survey that tested their knowledge in these areas, including the legal background for patient transfers, liability associated with transfer, qualification of prehospital personnel, as well as equipment and standing orders used when transporting critically ill patients. Two to three weeks later, all participants filled out a follow-up survey. Using case scenarios, these critical areas were tested and the participants provided information on how the lecture affected their experiences and confidence regarding patient transfers in their daily work life. **Results:** Participants had poor knowledge of the legal aspects of inter-facility patient transfers. They also had

limited knowledge regarding the clinical and legal scope of practice of EMS providers involved in patient transports. Participants rated their knowledge as poor to average on the pre-test. On follow-up, participants were noted to have significantly increased knowledge in both the medical and legal aspects tested. They felt more comfortable in accepting and facilitating patient transfers and felt that the educational intervention had affected their practice in a positive way. **Conclusions:** A one-hour educational intervention served as an effective tool to objectively increase the knowledge of emergency medicine residents and critical care fellows regarding the medico-legal aspects of inter-facility patient transfers. Participants also felt much more comfortable with patient transfers in their daily practice.

134. DEATH NOTIFICATION TRAINING: A SURVEY OF EMERGENCY MEDICAL SERVICES (EMS) PROVIDERS' NEEDS

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Background: Emergency medical services (EMS) providers are frequently called on to communicate death notifications in the field. Many EMS providers do not have formal training for this task. The purpose of this study is to explore EMS providers' attitudes toward death notification training. **Methods:** A convenience sample of Canadian EMS providers completed an online survey that ascertained their attitudes to death notification training. Descriptive and inferential statistics were calculated and subgroup analyses were performed. **Results:** 493 EMS providers with a mean age of 38.7 years (SD = 10.1 years) and an average of 14.2 years of experience (SD = 9.4 years) completed the survey. EMS providers are less confident communicating death notifications for pediatric, violent, and traumatic deaths. They receive minimal death notification training in their entry to practice and field training, and experienced providers are less likely to have training ($t(425) = -0.205, p = 0.229$). Older providers prefer to learn by more formal methods compared to younger providers, who want to learn informally from other providers' experiences. Overall, providers report that improving their communication skills when managing challenging deaths, when considering what to say, and when communicating with the family during a resuscitation would help them to communicate death notifications more effectively. They report that other EMS providers, people with similar experiences, other health professionals, and communication skills experts are the best facilitators for this training in the setting of mandatory continuing education and entry to practice education. Important topics include funeral arrangements for less experienced providers ($t(478) = -4.051, p = 0.000$), and current research ($t(478) = -1.607, p = 0.109$) and cultural differences in grief reactions ($t(478) = -2.949, p = 0.003$) for older providers, those with more experience ($t(473) = 2.237, p = 0.26$; $t(473) = -3.401, p = 0.001$), and those with higher levels of training ($\chi^2 = 7.965, p = 0.47$; $\chi^2 = 9.289, p = 0.26$). **Conclusions:** Limitations of this study include self-report of attitudes and a low response rate. This study suggests that training in managing challenging deaths and effective communication skills delivered by facilitators from multiple disciplines in varied formats is required to improve EMS providers' effectiveness in these challenging situations.

135. EFFECTS OF PARAMEDIC EDUCATION AND NOVEL ORAL ANALGESIA DIRECTIVE ON PREHOSPITAL PAIN ASSESSMENT, DOCUMENTATION, AND MANAGEMENT

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Background: An effective prehospital analgesia practice includes emphasis on pain assessment, documentation, and both pharmacologic and non-pharmacologic treatments. Recently, a novel oral analgesia directive was implemented in Haldimand County, a rural area of Ontario, Canada with a population of 45,000. The EMS service has primary care paramedics (PCPs, similar to EMT-D) only. The protocol allowed the PCPs to administer acetaminophen and ibuprofen in select patients with isolated extremity injuries. This study evaluated PCP assessment of pain and the patient's pain relief as reflected by pain scale documentation before and after an online education module and the oral analgesia directive implementation. The module focused on pain assessment, non-pharmacologic treatments, and the oral analgesia directive. **Methods:** Retrospective review of ambulance call reports (ACRs) with trauma codes for extremity injuries between January 1, 2011 and June 30, 2011 (before) and between January 1, 2013 and June 30, 2013 (after) were performed. The online education module was completed in the month of August 2012. The oral analgesia directive was implemented in September 2012. **Results:** Sixty-seven pre-education and 92 post-education ACRs were identified and reviewed. There was a significant improvement in pain scale documentation after the educational intervention (19.4% vs. 54.3%, $p < 0.001$). Documentation rate was further improved when oral analgesia was administered ($p = 0.005$). Only 18 out of 54 patients (33.3%) that met directive criteria received medication. Of those, pain scores of 6 patients (33.3%) were re-assessed and three patients had pain relief and 3 patients reported no change. There were no statistically significant relationships between patient's age, gender, initial vital signs, or transport time and analgesia administration. **Conclusions:** A self-directed online education module on prehospital pain appears to be an effective method of improving pain assessment among PCPs. Concurrent implementation of an oral analgesia directive appeared to have the largest impact on assessment and management of pain. Further education on protocol inclusion criteria and importance of re-assessment of pain should be emphasized in the future.

136. DEFINING COMPONENTS OF TEAMWORK IN PREHOSPITAL EMERGENCY MEDICAL SERVICES

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Background: Complex work environments require the use of teams, and prehospital care is no exception. Emergency medical services (EMS) professionals respond to high-stakes, time-sensitive situations as part of a multi-provider crew. Crew resource management (CRM) focuses on minimizing errors and improving safety and performance through teamwork skills. Many studies have examined the relationship and benefits of CRM in the emergency department; however, teamwork and its components have not been explored in the prehospital context. The objective of this study was to identify specific components of both team leadership and followership in the context of prehospital EMS. **Methods:** Ten national EMS experts were identified and invited to participate in a focus group. Utilizing the nominal group technique (NGT), participants were asked to answer the following question: "What are the specific components of team leadership and team followership on a single patient call where multiple EMS providers are present?" **Results:** All ten EMS experts participated in

this study (10/10; 100%). After completing the seven-step NGT process, eight components of team leadership and eight components of team followership were identified. Team leadership components included 1) creates an appropriate action plan; 2) receives, processes, verifies, and prioritizes information gain from team members; 3) communicates; 4) demonstrates confidence, maturity, compassion, and command presence; 5) reconciles incongruent information; 6) is willing to take charge; 7) is accountable for team-actions/outcomes; and 8) assesses the situation and resources and modifies the plan. Team followership components included 1) demonstrates followership; 2) is capable of appreciative inquiry; 3) is situationally aware; 4) does not freelance; 5) communicates; 6) ACCURATELY performs assigned tasks in a timely manner; 7) is safety conscious/advocacy; 8) leaves ego and rank at the door. **Conclusions:** A focus group with EMS experts identified eight components of team leadership, including planning and communication and eight components of followership, including situational awareness and safety consciousness. Future research should explore the benefits of CRM training in EMS.

137. THE PRODUCT OF END-TIDAL CARBON DIOXIDE AND AN ELECTROENCEPHALOGRAPH MEASUREMENT CORRELATES WITH CEREBRAL PERFUSION PRESSURE DURING CARDIOPULMONARY RESUSCITATION IN A SWINE MODEL OF CARDIAC ARREST

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Background: Non-invasive markers are lacking to assess cerebral function and perfusion during CPR. For >25 years ET_{CO}₂ values during CPR have been shown to correlate with coronary perfusion pressure and clinical outcomes. Further, electroencephalograms (EEG) have been used to measure brain wave activity but generally have not been shown to correlate with clinical outcomes during or after CPR. We hypothesized that a combined signal, incorporating measurements of both ET_{CO}₂ and an EEG, assessed with a bispectral index (BIS), correlates with cerebral perfusion pressure (CerPP) during CPR. A strong positive signal may provide an innovative way to predict successful resuscitation with favorable neurological outcome. **Methods:** Five female farm pigs (38 ± 3 kg) were studied using a model of cardiac arrest. Following surgical preparation, isoflurane was discontinued. Once the BIS value was 60-70, ventricular fibrillation (VF) was induced. After 4 minutes of untreated VF, three different methods of CPR [standard CPR (S-CPR), active compression decompression (ACD) CPR plus an impedance threshold device (ACD-ITD), and ACD plus an intrathoracic pressure regulator (ACD-IPR)] were performed sequentially for 4-minute epochs. Millar catheters were used to measure aortic (AO) and intracranial pressures (ICP). BIS values and suppression ratio (SR) were monitored. Results are reported as mean mmHg ± SD. A Spearman rank test was used to correlate the product of BIS × ET_{CO}₂ with CerPP during CPR. **Results:** CerPP was significantly higher with the ACD-IPR intervention (24.26 ± 6.74) as compared with ACD-ITD (21.99 ± 12.11) and S-CPR (14.06 ± 10.53). ACD-IPR treatment also resulted in a higher BIS × ET_{CO}₂ product (1832.6 ± 793.3) than the interventions of ACD-ITD (1700.0 ± 748.0) and S-CPR (859.6 ± 529.6). The Spearman rank coefficient was statistically significant between the BIS × ET_{CO}₂ product and CerPP (correlation coefficient = 0.56, p = 0.03). SR was between 0 and 5 in all CPR interventions. Con-

clusions: These findings support the hypothesis that a new index, the product of an EEG BIS signal and ET_{CO}₂ varied in a manner that correlates with CerPP during CPR. Further studies to determine if this non-invasive neurological index is predictive of awakening in pigs are underway.

138. COMPARISON OF STANDARD CPR VERSUS CPR WITH AN INTRATHORACIC PRESSURE REGULATOR VERSUS ACTIVE COMPRESSION DECOMPRESSION CPR PLUS AN IMPEDANCE THRESHOLD DEVICE DURING OUT-OF-HOSPITAL CARDIAC ARREST

Amy Raubenolt, Joshua Mastenbrook, Kevin Franklin, William Fales, *Western Michigan University*

Background: This feasibility study, performed under FDA Investigation Device Exemption (21CFR812), focused on two new CPR methods to lower intrathoracic pressure in patients with out-of-hospital cardiac arrest. During cardiopulmonary resuscitation (CPR), augmentation of negative intrathoracic pressure following compressions lowers intracranial pressure, enhances cardiac preload, and increases cardiac and cerebral perfusion. **Methods:** Standard (S)-CPR was compared with 1) S-CPR with an intrathoracic pressure regulator designed to lower airway pressures to -12 cmH₂O after positive pressure ventilation (S-CPR + IPR) and 2) active compression decompression (ACD) CPR with a new adhesive-based device + impedance threshold device (ACD + ITD). Subjects were prospectively randomized and met final inclusion criteria if femoral arterial access was established in the field and = 5 minutes of hemodynamic data were recorded. Subjects who presented in unwitnessed asystolic arrest were excluded. Systolic blood pressure (SBP) was the primary endpoint. A one-way ANOVA was used for statistical comparison, with p < 0.05 considered statistically significant. **Results:** Of 48 initially enrolled patients, 15 met final inclusion criteria (3 S-CPR + IPR, 6 ACD + ITD, and 6 S-CPR). The time from 9-1-1 call to first measured pressures averaged 41 ± 13 minutes (range was 24-73 min), in part due to the design of the study. SBP increased with S-CPR + IPR to 141 ± 11 mmHg compared to 63 ± 8 mmHg with ACD + ITD (p < 0.01) and 59 ± 12 mmHg with S-CPR (p < 0.01). DBP was 52 ± 28 with S-CPR + IPR, 16 ± 5 with ACD + ITD, and 21 ± 7 with S-CPR (NS between groups). Peak ET_{CO}₂, a measure of circulation during CPR, trended higher with S-CPR + IPR (48 ± 24 mmHg) and ACD + ITD (42 ± 7 mmHg) compared with S-CPR (38 ± 28 mmHg), but the differences were not significant. Interpretation is limited due to the low number of patients meeting final enrollment criteria. **Conclusions:** In this feasibility study, use of S-CPR + IPR provided the highest SBP observed. Augmentation of negative intrathoracic pressure with both S-CPR + IPR and ACD + ITD provided higher blood pressure and ET_{CO}₂ values than S-CPR alone. Further studies are needed to correlate improved BP and perfusion associated with these new devices with long-term clinical outcomes.

139. AN ASSESSMENT OF CHEST COMPRESSION QUALITY PERFORMED ON SCENE VERSUS IN THE BACK OF A MOVING AMBULANCE

Jonathan Studnek, Allison Infinger, Steve Vandeventer, *Mecklenburg EMS Agency*

Background: Chest compression quality has been shown to be associated with survival to hospital discharge among out-of-hospital cardiac arrest patients. However, there has been limited research regarding compression quality in a moving ambulance. Previous research has

largely been conducted using manikins with focus on compression depth, a single component of quality CPR. The objective of this study was to assess chest compression quality performed on scene versus in an ambulance using data collected on cardiac arrest patients. **Methods:** This retrospective analysis utilized chest compression data extracted from cardiac monitors from a large urban emergency medical service (EMS) from January 1, 2013 to July 30, 2013. Patients were included if resuscitation was attempted, a transport occurred, and no return of spontaneous circulation was documented. CPR data were extracted in 30-second segments with each segment classified as occurring on scene or during transport. Each segment provided data on flow time (percentage of time compressions occurred), average depth of compressions (mm), count of shallow compressions, count of compressions with leaning, and percentage of adequate compressions. Five minutes were excluded from analysis prior to the documented depart scene time for patient movement to the ambulance. Means and 95% confidence intervals were reported with paired t-tests to assess for differences. **Results:** There were 44 patients included, contributing 2,963 segments of CPR data with 45.5% of compressions occurring after scene departure. Flow time percentage (on scene: 89.5, 88.5-90.4 vs. in ambulance: 83.5, 82.0-84.9), shallow compressions (10.9, 10.1-11.8 vs. 15.6, 14.6-16.5), average depth (45.4, 44.9-45.9 vs. 41.3, 40.6-42.1), and adequate compressions percent (78.5, 76.9-80.1 vs. 69.4, 67.8-71.1) were significantly better on scene compared to after scene departure. However, leaning during compressions (6.4, 5.8-7.0) was significantly worse on scene than after scene departure (4.4, 3.9-4.8; p < 0.001). **Conclusions:** This analysis demonstrated that CPR performed on cardiac arrest patients is of higher quality when performed on scene compared to after departure. The decreased effectiveness of chest compressions may be detrimental to patients who are transported prematurely. EMS administrators and medical directors should consider delaying patient transport until high-quality chest compressions have been performed on scene for an appropriate length of time.

140. COMPRESSIONS-ONLY CPR LEADS TO INCREASED SURVIVAL AMONG OUT-OF-HOSPITAL CARDIAC ARRESTS

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Background: Based on recent evidence, EMTs and first responders in a metropolitan area (population >250,000) implemented a continuous compressions protocol, cardiocerebral resuscitation (CCR), for out-of-hospital cardiac arrest (OHCA). The software CODE STAT, which provides retrospective feedback, was later implemented. **Objective:** To determine if continuous chest compression protocol affects OHCA survival-to-discharge rates over traditional CPR and to evaluate the significance of CCR protocol's components on survival-to-discharge. **Methods:** A retrospective chart review was conducted for June 1, 2009 to May 31, 2010, establishing baseline CPR data, and June 1, 2010 to May 31, 2013, for CCR data. CCR's focus and therefore protocol compliance criteria were based on Bobrow's 2008 MICR study. Criteria were 200 pre-shock and post-shock compressions, endotracheal intubation delayed for 3 rounds CCR or 6 minutes, and epinephrine administered within first 2 rounds or 4 minutes. The study included OHCA's in adults with probable cardiac etiology. Survival-to-discharge was the primary outcome.

Compliance was judged on percentage of applicable criteria met. CODE STAT computed compressions frequency and ratio (time spent performing compressions in relation to total time); reports for the first 6 minutes were averaged. Chi-squared tests and logistic regression were used in analysis. **Results:** 740 patients were included in the OHCA study (CPR: n = 179, CCR: n = 561), and 66 CCR patients in the CODE STAT analyses. Overall OHCA survival-to-discharge rates increased significantly (13.4% survival CPR, 14.6% CCR; p = 0.040; odds ratio [OR] = 1.10; 95% confidence interval [95%CI]: 0.68, 1.80), as did the subset of witnessed, ventricular fibrillation initial rhythm (30.8% survival CPR, 42.7% CCR; p = 0.035; OR = 1.68; 95% CI: 0.65, 4.29). 13 of 66 CODE STAT cases (20%) were 100% protocol compliant. Percent compliance was significantly correlated to outcome (p = 0.025; OR = 1.05; 95%CI: 1.01, 1.09). Neither any particular criterion nor compressions frequency correlated to outcome. Compressions ratio was significantly related to outcome (p = 0.026; OR = 0.94; 95%CI: 0.89, 0.99). **Conclusions:** CCR yielded increased OHCA survival-to-discharge rates. Overall compliance to protocol was a significant factor in patient outcome, but no individual criterion was significant. The compressions ratio's negative significance should be investigated further. The limited number of cases of CODE STAT analysis warrants further investigation, yet overall results support CCR protocol.

141. CHEST COMPRESSION QUALITY DECLINES IN THE MINUTES PRECEDING SCENE DEPARTURE IN OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Previous studies have shown that chest compression (CC) quality declines during ambulance transport. However, the quality of CCs while preparing a patient for transport and transferring to the ambulance has not been described in the clinical setting. We tested the hypothesis that CC quality diminishes during the transition from the scene to the ambulance. **Methods:** CC quality was monitored at two EMS agencies using an E Series defibrillator with CC sensing capability (ZOLL Medical) during the treatment of consecutive out-of-hospital cardiac arrest patients who received CC on scene and were transported to the ED with ongoing CC. Minute-by-minute CC process data were averaged for all minutes without ROSC during late scene treatment (i.e., 3 minutes prior to transport) and early scene treatment (i.e., all prior minutes at scene). Paired t-tests were used to compare CC quality during late scene vs. early scene treatment. **Results:** A total of 211 cardiac arrest events requiring CPR at the time of scene departure were studied (mean age 64 years, 67% male, 8% survival to discharge). CC fraction, rate, and percent of compressions >2 inches were significantly reduced during late vs. early scene treatment and variability in depth and rate (standard deviation) were increased during late scene treatment. Mean CC fraction (%): early scene (ES) 74 ± 16 vs. late scene (LS) 61 ± 23, p < 0.001; mean depth (in.): ES 1.92 ± 0.47 vs. LS 1.87 ± 0.45, p = 0.11; mean rate (cpm): ES 108 ± 15 vs. LS 103 ± 20, p < 0.001; release velocity (in./sec): ES 12.02 ± 2.82 vs. LS 11.96 ± 3.01, p = 0.8; SD depth (in): ES 0.18 ± 0.06 vs. LS 0.30 ± 0.14, p < 0.001; SD rate: ES 13 ± 5 vs. LS 23 ± 9, p < 0.001; CC > 2 in (%): ES 53 ± 33 vs. LS 45 ± 32, p < 0.001. **Conclusions:** CC quality declines in the minutes preceding transport, presumably because of the difficulty of performing high-quality CCs while preparing the patient for transport and

moving the patient to the ambulance. The impact of this finding on outcome requires further study.

142. REDEFINING ROLES FOR CARDIAC ARREST: TESTING THE UTILITY OF A CPR FEEDBACK COACH

Allison Infinger, Steve Vandeventer, Jonathan Studnek, Mecklenburg EMS Agency

Background: Real-time CPR feedback devices (CPR-FD) have been shown to improve CPR quality by providing audio and visual prompts. Despite use of CPR-FD, variability in CPR performance exists. The objective of this study was to determine if CPR performance would be improved through an intervention that assigned a responder to interpret visual feedback and provide real-time coaching. It was hypothesized that this intervention would significantly improve compression depth compliance and reduce time to defibrillation. **Methods:** This pre/post study collected data from a single advanced life support EMS agency with basic life support first response provided by the fire department. The intervention modified a current focused cardiac arrest protocol by training fire department captains to interpret the CPR waveform displayed on the cardiac monitor and provide immediate feedback concerning compression depth. Prior to systemwide implementation, the intervention was pilot tested in April 2013 using a simulation center and five of the areas busiest fire crews. This was followed by a period of data collection where the same crews utilized the intervention during clinical practice, concluding in a systemwide training in June 2013. The pre-intervention phase was defined as March 2013 and post-intervention as July 2013. CPR data captured from the cardiac monitor included rate, compliance with compression depth, time to defibrillation (the interval between the end of a compression cycle and shock delivery), and flow time. Patients were excluded if all four metrics were unrecorded. **Results:** There were 109 cardiac arrest patients during the 2-month study period, with 81 patients eligible for analysis. Median compliance with compression depth was 82.2% (IQR: 51%-95.4%) in the pre-intervention phase compared to 93.8% (IQR: 76.2%-98.9%; p < 0.05) in the post-intervention phase. Rate, time to defibrillation, and flow time saw no improvement in the post-intervention phase. **Conclusions:** The use of CPR-FD alone may not adequately ensure adequate CPR. Assigning a responder to interpret CPR feedback and provide coaching improved compliance with compression depth in this analysis. EMS administrators and medical directors should consider dedicating a responder to interpret visual feedback from the CPR-FD and act as a CPR coach in their resuscitation strategy.

143. IMPORTANCE OF RELEASE VELOCITY FOR IMPROVED HEMODYNAMIC POWER AT VARYING CHEST COMPRESSION DEPTHS

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Background: During cardiac arrest, chest compression (CC) release velocity or waveform has been suggested to be important for coronary perfusion and returning blood flow to the heart. A detailed investigation of the impact of changes in CC waveform on blood flows and pressures during prolonged CPR has yet to be thoroughly performed. **Methods:** CPR hemodynamics in 12 domestic swine (~30 kg) were studied using standard physiological monitoring. Flow probes were placed on the abdominal aorta, the inferior vena cava (IVC), the right

artery and vein, the right common carotid and external jugular. Ventricular fibrillation (VF) was electrically induced. Mechanical CC were started after 10 minutes of untreated VF. CC release was changed so that sternal recoil lasted 100 ms, 200 ms, or 300 ms. CC were delivered at a rate of 100 per minute and at a depth of 1.25 inch (n = 9) and at a depth of 1.9 inch (n = 3). Transitions between waveforms occurred every 2 min and were randomized. **Results:** Analyses of the recorded hemodynamic power (power = flow × pressure) indicated that there was a significant difference in the amount of energy each CC waveform transferred to the blood in the IVC during 1.25 inch CC (100 ms = 0.021 ± 0.008, 200 ms = 0.020 ± 0.008, 300 ms = 0.017 ± 0.006 watts, p < 0.001 for ANOVA) and during 1.9 inch CC (100 ms = 0.011 ± 0.009, 200 ms = 0.011 ± 0.008, 300 ms = 0.010 ± 0.008 watts, p = 0.05 for ANOVA). Similar significant differences between waveforms were observed with absolute IVC flow, but not for coronary perfusion pressure. **Conclusions:** CC release velocity at varying depths had a similar effect on hemodynamic power in the IVC, with faster release being most advantageous. Care should be taken when performing CPR to ensure proper chest compression release.

144. A CASE SERIES: HEMODYNAMICS OF LUCAS DEVICE PLUS AN ITD IN CARDIAC ARREST

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Background: Cardiac arrest with a rhythm of PEA or asystole remains an almost uniformly fatal process in the community. A recent study involving an impedance threshold device (ITD) in combination with active compression-decompression cardiopulmonary resuscitation (ACD-CPR) has shown a survival benefit over standard CPR. However, there is currently no literature describing the hemodynamic parameters associated with a combination of LUCAS 2 device CPR (LUCAS-CPR) and an ITD in cardiac arrest. Little is known regarding the hemodynamics of these two devices in combination in cardiac arrest. The goal was to determine if there is adequate perfusion, oxygenation, and ventilation in a case series of patients in cardiac arrest. **Methods:** A retrospective chart review was performed in a single suburban Houston, Texas EMS service which routinely uses both LUCAS-CPR and an ITD in cardiac arrest. Inclusion criteria: PEA or asystole cardiac arrest with no ROSC recorded, ITD + LUCAS-CPR, hemodynamic parameters of BP, SPO₂, EtCO₂, and ECG were recorded in real time. Thirteen cases were analyzed using Minitab 142 and simple statistics and boxplots were created displaying the characteristics of the hemodynamic measures. **Results:** For the 13 patients in cardiac arrest without ROSC, the parameters were MAP: median 83 mmHg, mean of 86 mmHg (SD 31), EtCO₂: median 28, mean of 31 (SD 17), SpO₂: median 85%, mean 82% (SD 16). **Conclusions:** This data set demonstrates near-normal parameters of perfusion, oxygenation, and ventilation in cardiac arrest patients with an initial rhythm of asystole or PEA. This represents optimization of cardiac arrest perfusion management. The concern, however, is that despite excellent hemodynamic parameters, none of these patients obtained ROSC. Further studies need to be performed to determine why resuscitation is not successful given optimized hemodynamics.

145. THE AVAILABILITY OF PRIOR ECGS IMPROVES PARAMEDIC ACCURACY IN IDENTIFYING STEMI'S

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Background: Early and accurate identification of ST-elevation myocardial infarction (STEMI) by prehospital providers has been shown to significantly improve door to balloon times and improve patient outcomes. Previous studies have shown that paramedic accuracy in reading 12-lead ECGs can range from 86 to 94%. However, recent studies have demonstrated that accuracy diminishes for the more uncommon STEMI presentations (i.e., anterior and lateral). Unlike hospital physicians, paramedics rarely have the ability to review previous ECGs for comparison. Whether or not a prior ECG can improve paramedic accuracy is not known. Prior ECGs improve paramedic accuracy in identifying STEMI. **Methods:** 130 paramedics were given a single clinical scenario. Then they were randomly assigned 12 computerized pre-hospital ECGs, 6 with and 6 without an accompanying prior ECG. All ECGs were obtained from a local STEMI registry. For each ECG paramedics were asked to determine whether or not there was a STEMI and to rate their confidence in their interpretation. To determine if the old ECGs improved accuracy we used a mixed effects logistic regression model to calculate p-values between the control and intervention. **Results:** The addition of a previous ECG improved the accuracy of identifying STEMI from 75.5% to 80.5% ($p = 0.015$). A previous ECG also increased paramedic confidence in their interpretation ($p = 0.011$). **Conclusions:** The availability of previous ECGs improves paramedic accuracy and enhances their confidence in interpreting STEMI. Further studies are needed to evaluate this impact in a clinical setting.

146. IMPACT OF EMS PREHOSPITAL ACTIVATION OF CARDIAC CATHETERIZATION LAB ON DOOR TO BALLOON AND EMS TO BALLOON TIMES

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Background: Rapid identification and treatment of an ST-elevation myocardial infarction (STEMI) reduces mortality and morbidity. The times to treatment, measured as emergency department (ED) door-to-balloon (D2B) or emergency medical services (EMS)-to-balloon (E2B) time are important quality measures. For years, area EMS have been transmitting electrocardiograms (ECGs) electronically allowing ED physicians to activate the cardiac catheterization lab ahead of the patient's arrival when an STEMI is detected. At our institution 80% of STEMI arrive by EMS, 60% of them when the catheterization lab is closed and the team must be called in from home. In 2012, select EMS agencies began activating the catheterization lab directly from the field before transmitting the ECG to the ED, speeding up the process. The purpose of this study was to determine the impact of EMS catheterization lab activation on D2B and E2B times. **Methods:** This was a quality assurance study in which 2 years of non-human subjects data were analyzed from our STEMI database. All EMS patients for whom the EMS or first ED ECG showed a STEMI were included. The D2B and E2B times were analyzed by year and by mode of activation. We report mean times, with 95% confidence intervals (CI). Two sample t-tests were performed to determine significance, which was defined as $p = 0.05$. **Results:** Data from 225 STEMI patients were analyzed, 107 patients in 2011 and 118 in 2012 with mean D2B times of 45.7 minutes (CI 42.4-49.0) and 42.0 minutes (CI 39.4-44.7). Mean E2B times were 75.3 minutes (CI 71.0-79.6) and 71.0 minutes (CI 68.1-73.9), respectively. In 2012, EMS field activation occurred in

22 patients with a D2B time of 33.4 minutes (CI 28.5-38.2) compared to a non-EMS field activation time of 44.9 minutes (CI 42.7-47.1), a decrease of 11.5 minutes ($p = 0.011$). The E2B time for EMS field activations was 63.4 minutes (CI 57.8-69.0) compared to 74.1 minutes (CI 71.4-76.8) when field activation did not occur, a decrease of 10.7 minutes ($p = 0.013$). **Conclusions:** In our study population, EMS activation of the cardiac catheterization lab decreased door-to-balloon and EMS-to-balloon times.

147. EFFECTS OF PREHOSPITAL ECG USE AND PATIENT RESIDENCE DISTANCE FROM PCI CENTER ON TIME TO DEVICE ACTIVATION IN ST SEGMENT ELEVATION MYOCARDIAL INFARCTION: A RETROSPECTIVE ANALYSIS FROM THE NCDR

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Background: American Heart Association guidelines recommend <90 minutes from first medical contact (FMC) to reperfusion for ST segment elevation myocardial infarction (STEMI) patients. Prehospital electrocardiograms (ECGs) reduce time to reperfusion, but the relative influence of patient distance from a percutaneous coronary intervention (PCI) center on this effect is unclear. We evaluated the relationship between patient distance from a PCI center, prehospital ECG use, and interval from FMC to device activation among patients with STEMI. **Methods:** We performed a retrospective cohort study including all STEMI patients in the ACTION Registry-Get With the Guidelines from 7/1/2008 to 9/30/2012 who were transported by ground emergency medical services (EMS) to a PCI center. Patient distance was defined as the driving distance from the patient's home zip code to the PCI center address as calculated by Google Maps. Home zip code was used as a surrogate for EMS call location. Patient distance was classified into tertiles (<7.1 mi, 7.1-16.3 mi, >16.3 mi), and simple linear regression was used to characterize the interaction between prehospital ECG use and patient distance with respect to time to device activation. **Results:** Of the 29,506 STEMI patients, 19,690 (67%) received a prehospital ECG. The median patient distance to PCI center was 11.0 mi among patients with a prehospital ECG and 9.9 mi among those without. Overall, a prehospital ECG reduced the FMC to device activation time by 10.9 minutes ($p < 0.001$). This reduction in time from FMC to device was consistent across tertiles of distance (1st, median 11 minutes; 2nd, median 11 minutes; 3rd, median 10 minutes). The effect of prehospital ECG is attenuated by 0.8 minutes for every 10-mile increase in distance (interaction $p = 0.0002$). During off hours, median time from FMC to device activation was longer in each distance tertile when compared to work hours (86 vs. 68, 86 vs. 70, and 92 vs. 77 minutes, respectively; $p < 0.001$ for all). **Conclusions:** Prehospital ECGs are commonly used among STEMI patients and reduce the time from FMC to device activation by approximately 10 minutes. Patient distance from a PCI center was not associated with this time interval, but presentation during off hours was associated with longer times.

148. NOVEL APPLICATION OF 9-1-1 DISPATCH IN STEMI ALERT PROCESS DECREASES DOOR TO BALLOON TIMES (DTB)

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Background: Some hospital systems have incorporated EMS-directed activation of the cardiac catheterization lab (CCL) for STEMI pa-

tients. The focus on streamlining this process has remained largely centered on intra-hospital variables. We sought to determine the potential reduction in DTB by allowing paramedics to perform prehospital STEMI notification by brief communications (one sentence with age, gender, STEMI, and ETA) through EMS 9-1-1 dispatchers who directed the request to hospitals. Theoretically, this allowed immediate CCL activation even when on-scene variables delayed conversation. **Methods:** The study setting was a single suburban academic hospital with ED seeing $>120,000$ patients/year and a regional PCI referral center. STEMI notifications from 7/2010 to 7/2012 occurred by either standard direct EMS to physician notification or by immediate 9-1-1 dispatch notification. A retrospective chart review with statistical analysis was performed to assess a difference in DTB between the groups. **Results:** 1,405 total STEMI notifications occurred. 866 notifications arrived by EMS. 730 notifications were excluded due to confounding events, such as cardiac arrest, arrhythmia, death, resolution of EKG changes and/or symptoms, cardiologist decision not to perform PCI, or prior stabilization at a referring facility. Of the remaining patients, sequential analysis of 64 patients in each group was performed. This powered the study to show significance for a 10-minute difference. The average DTB for the standard communication method was 57.6 minutes (SD 4.5). 9-1-1 dispatcher-aided communication average DTB was 46.1 minutes (SD 3.2) The difference between the two groups was an average of 11.5 minutes ($p = 0.001$.) In the 9-1-1 dispatcher-aided group 92% (59/64) met national standards of < 90 -minute DTB. Only 64% (41/64) met this goal in the standard communication group ($p < 0.001$.) **Conclusions:** Brief, early notification of STEMI by 9-1-1 dispatchers achieves earlier CCL activation in a hospital system that already utilizes EMS directed CCL activation. This practice substantially decreased DTB and allowed a far higher percentage of patients to meet the DTB < 90 -minute metric.

149. A CHARACTERIZATION OF STEMI ACTIVATIONS BY PATIENT'S PREHOSPITAL PRESENTING LOCATION

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Background: Early identification of patients presenting to emergency medical services (EMS) with an ST elevation myocardial infarction (STEMI) has been shown to decrease time to definitive treatment. A further understanding of the characteristics of patient's presenting to EMS with STEMI may assist in the development of care processes that improve either recognition or expedite delivery of patients to appropriate facilities. The objective of this study was to identify characteristics of STEMI patients that vary by a patient's presenting location. **Methods:** This was a retrospective study of STEMI patients presenting to one of three PCI centers transported by a single EMS agency between May 2007 and March 2011. Data were extracted from prehospital records and an in-hospital STEMI database. Patients were classified by EMS as presenting at either home or some other public location. Other patient characteristics assessed included the day of the week and time of day of presentation, gender, race, age, and number of comorbidities. False-positive STEMI activations were excluded from this analysis. Descriptive statistics were calculated with chi-squared analysis used to assess for significant associations. **Results:** There were 238 patients included in this analysis, of which 71.8% were found by EMS at a location classified as home. The average age of patients was

60.6 years (SD = 14.3) and they were predominantly male (70.2%) and white (60.1%), with 59.7% presenting to EMS between 06:00 and 18:00. Time of day and race were the two characteristics of patients that varied by the patients presenting location. 77.7% of patients presenting to EMS at a location other than home did so between the hours of 06:00 and 18:00 with only 53.0% of patients presenting at home during the same hours ($p = 0.01$). Further, 80.0% of patients who were classified as a race other than white presented to EMS at home compared to 66.4% of white patients ($p = 0.023$). **Conclusions:** This study indicated that a clear majority of prehospital STEMI patients presented to EMS in the home. Results from this study may further justify educating family members regarding signs and symptoms, and the importance of early EMS activation to help reduce morbidity and mortality.

150. PREVALENCE OF PREHOSPITAL ELECTROCARDIOGRAPH ST-ELEVATION MYOCARDIAL INFARCTION MIMICS

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Background: Emergency medical services (EMS) are a vital component of rapid identification and transportation of patients with ST-elevation myocardial infarctions (STEMI) for definitive treatment. Such a task may be impeded, however, by ECG rhythms that mimic STEMI, such as left bundle branch blocks (LBBB), right bundle branch blocks (RBBB), ventricular paced rhythms (VP), left ventricular hypertrophy (LVH), and supraventricular tachycardia (SVT). Distinguishing between these rhythms is dependent on provider training. Our objective was to evaluate the prevalence of prehospital ECG STEMI mimics. Knowing this can help guide EMS training and prehospital STEMI team activation protocols. **Methods:** Our setting is a community-based university-affiliated STEMI receiving center hospital with an ED seeing over 77,000 adult patients a year and providing medical direction for more than 21,000 EMS transports a year. ECGs received electronically from EMS are stored in an electronic database. Eight hundred ECGs were randomly selected from the 4,979 ECGs in the 2012 database. We included for analysis the first 600 that were not determined to be unreadable secondary to missing data in one or more leads. The 600 ECGs were examined separately by two emergency medicine physicians for the presence of STEMI, STEMI mimics, or no STEMI/STEMI mimics using rigid diagnostic criteria. We present proportions with 95% confidence intervals (CI). **Results:** Of the 800 ECGs randomly selected, seven were removed because they were duplicates and 19 were unreadable (19/793, 2.4%). Of the 600 ECGs interpreted, 25 STEMI were identified (4.2%; 95% CI, 2.7%-6.1%). Twenty-six percent of the ECGs (155/600 95% CI, 22.4%-29.5%) displayed one of the STEMI mimics: 45 RBBB (7.5%; 95% CI, 5.5%-9.9%), 28 LBBB (4.7%; 95% CI, 3.1%-6.7%), 48 LVH (8.0%; 95% CI, 6.0%-10.5%), 13 SVT (2.2%; 95% CI, 1.2%-3.7%), and 21 VP (3.5%; 95% CI, 2.2%-5.3%). **Conclusions:** In our study population EMS providers were more likely to see STEMI mimics than they were to see STEMI. For our EMS providers to be well trained in STEMI identification they must be taught STEMI mimics as well.

151. SYSTEMATIC REVIEW AND META-ANALYSIS OF THE BENEFITS OF PREHOSPITAL 12-LEAD ECG CONFIRMATION IN STEMI PATIENTS

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Background: Prehospital identification of ST-segment elevation myocardial infarction (STEMI) patients transported by emergency medical services (EMS) with 12-lead electrocardiography (ECG) confirmation can improve patient outcomes. Previous reviews of this strategy showed imprecision and were published prior to the release of a number of newer studies. The objective of this study was to present an updated review of prehospital identification of STEMI patients transported by EMS with 12-lead ECG confirmation versus standard or no cardiac monitoring. **Methods:** EMBASE, PubMed, and Cochrane Library were searched using controlled vocabulary and keywords. Randomized controlled trials and observational studies were included. Outcomes included short-term mortality (≤ 30 days), door-to-balloon/needle time or first medical contact-to-balloon/needle time. Pooled estimates were determined, where appropriate. Results were stratified by percutaneous coronary intervention (PCI) or fibrinolysis. **Results:** The search yielded 1,857 citations of which 68 full-texts were reviewed and 16 studies met the final criteria: 15 included data on PCI and 3 on fibrinolysis (2 included both). Observational studies limited the quality of evidence; however, a number of studies were identified and there were no serious threats of inconsistency, imprecision, or methodological bias that would further downgrade evidence from a low quality. Where PCI was performed, prehospital 12-lead ECG confirmation was associated with a 39% reduction in short-term mortality (8 studies; $n = 6,339$; RR 0.61; 95%CI = 0.42-0.89; $p = 0.01$; $I^2 = 30\%$) compared to standard or no cardiac monitoring. Where fibrinolysis was performed, prehospital 12-lead ECG confirmation was associated with a 29% reduction in short-term mortality (1 study; $n = 17,026$; RR = 0.71; 95%CI = 0.54-0.93; $p = 0.01$). First medical contact-to-balloon, door-to-balloon and door-to-needle times were consistently reduced, though large heterogeneity generally precluded pooling. **Conclusions:** The present study adds to previous reviews by identifying and appraising the strength and quality of a larger body of evidence. Prehospital identification with 12-lead ECG confirmation was found to be associated with reductions in short-term mortality, first medical contact-to-balloon, door-to-balloon and door-to-needle time.

152. IMPLICATIONS OF PREHOSPITAL ELECTROCARDIOGRAM TRANSMISSION AND EMERGENCY DEPARTMENT RECEIPT TIMES ON PREHOSPITAL CARDIAC CATHETERIZATION LAB ACTIVATION

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Background: Chest pain warrants a rapid assessment, including an early 12-lead ECG. Rapid identification of ST elevation myocardial infarctions (STEMIs) or new left bundle branch blocks is of critical importance. Established guidelines emphasize the importance of early STEMI identification and minimization of door-to-balloon (DTB) times. Prehospital identification of STEMI may result in earlier cardiac catheterization lab (CCL) activation. However, meeting first ECG-to-CCL activation time guidelines may be challenging for the emergency department (ED) to comply with when using prehospital ECGs. **Objective:** To study the timeliness of prehospital ECG arrival for review by ED physicians to identify potential delays. Such delays may be inappropriately attributed to the ED when assessing compliance of first ECG-to-CCL activation time of < 5 minutes recommended by the Society of Chest Pain Centers. Design: Retrospective ob-

servational convenience sample. Setting: Urban tertiary academic hospital. Data set: All prehospital ECGs transmitted by 13 EMS agencies through LifeNet Systems™ from January 1, 2013, through June 30, 2013. Protocol: ECGs were reviewed for times obtained and received. The time difference for each ECG was calculated (i.e., obtained to received time (OTRT)). The mean and median OTRTs were found. Average OTRTs were calculated for each agency. **Results:** Out of 1,700 ECGs, 35 had incomplete data and 1 was removed for being an extreme outlier (OTRT 22 hours 58 minutes 51 seconds), resulting in 1,664 ECGs with complete data. Mean and median OTRTs were 5 minutes 54 seconds and 3 minutes 23 seconds, respectively (range 14 seconds to 8 hours 56 minutes 28 seconds). Eleven of the 13 agencies had average OTRTs of no more than 8 minutes 14 seconds. Potential causes for prolonged OTRTs include 1) EMS delay in initiating ECG transmission; 2) network delays in processing; 3) incorrect times due to lack of time synchronization; and 4) delay in recognition of ECG arrival in the ED. **Conclusions:** Printed prehospital ECG times do not accurately reflect the time information becomes available to the ED physician and should not be used as a benchmark for first ECG-to-CCL activation times. Further research should investigate these time delays and focus on methods to reduce transmission delays.

153. THE ENVIRONMENTAL IMPACT OF THE EMS SUPPLY CHAIN

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Objective: To estimate the life cycle emissions of U.S. EMS systems, including emissions from supply chain process, and identify the components of the supply chain that contribute most to those emissions. **Methods:** The websites for 200 randomly selected U.S. cities and counties were searched to obtain publicly available EMS budget information for the two most recent budget years. Where line-item budgets were available, the consumer price index was used to convert expenditures to standard year (2002) amounts. Published input-output-based emissions multipliers, accounting for emissions from the upstream and downstream processes associated with any product or service, were then used to calculate "indirect" emissions related to those expenditures. We also calculated the volume of diesel, gasoline, and natural gas consumed by each system (amount spent average price), and used volume-based multipliers to calculate emissions from "direct" energy consumption. "Indirect" and "direct" emissions were summed to calculate life cycle emissions. **Results:** Detailed line-item budgets were available for nine EMS systems located in seven states (population: 7,500 to 400,000; annual response volume: 1,200 to 90,000; average expenditures: $\$50 \pm 20$ per capita, $\$290 \pm 128$ per response). Over 16 total budget years, these EMS systems spent a combined \$94.7 million (in 2002 dollars) and generated 21,877 tons of carbon dioxide equivalent (CO₂e) emissions, or 231 tons CO₂e per \$1 million of expenditure. Total EMS-related life cycle emissions for the U.S. were estimated at 3 million tons CO₂e annually (95% CI: 2.3 to 3.6 million tons CO₂e). The non-energy supply chain contributed 25% of EMS-related life cycle emissions. Purchases of medical supplies and equipment were the largest contributor to supply chain emissions (25%), followed by vehicle purchases/leases (19%) and vehicle maintenance (10%). Other notable contributors were administrative processes (billing, financial and professional services, 10%), office supplies and equipment (8%), and pharmaceuticals and medical gasses (3%). **Conclusions:** Direct emissions,

primarily from vehicle fuel consumption, are the clear priority for EMS sustainability initiatives, but the supply chain accounts for 25% of EMS-related emissions. Reducing waste in the EMS supply chain could have dual benefits of reducing system operational costs and reducing greenhouse gas emissions.

154. EMERGENCY MEDICAL SERVICE SUPER-USER RESOURCE UTILIZATION: THE LOS ANGELES EXPERIENCE

Stephen Sanko, Marc Eckstein, Keck School of Medicine of USC, Los Angeles Fire Department

Background: Overutilization of emergency medical services (EMS) by a select group of “super-users” strains prehospital resources, though few systems have formally reported this. The objective of our study was to quantify the frequency of EMS responses, the resources mobilized, clinical interventions provided, and financial burden that this group represents for a large, urban EMS provider agency. **Methods:** A retrospective review of electronic medical records from the Los Angeles Fire Department (LAFD), the EMS provider for a city of 3.8 million people, was used to identify the 40 most frequent EMS users from July 2011 to June 2012. Outcomes reported included the number of fire department resources deployed for each patient encounter, total resource turnaround time (from time of alarm to being back in service), and the financial debt of each frequent user. **Results:** During the 12 months under study, LAFD providers responded to approximately 336,000 incidents, resulting in 204,900 patient transports. The top 40 EMS “super-users” accounted for 2,359 unique encounters resulting in 2,209 transports, or 1% of all system transports, which included 1,836 single-vehicle and 602 multivehicle dispatches. 37 (92.5%) of the 40 super-users had days in which they required transport by LAFD EMS multiple times. On average, these 37 patients had over 6 days per year (range: 1-32 days) in which they required multiple transports, including one individual with 32 multitransport days. Overall, 2,980 vehicles were involved in care of these patients, including 2,080 BLS and 900 ALS deployments. EMS turnaround time dedicated to these 40 individuals was over 1,540 person-hours, including 540 hours of ALS service. The total charges for these 40 patients over the study period were \$2.4 million, of which \$231,101 was paid. The median balance owed by each of these patients was \$20,232. **Conclusions:** An identified small group of EMS “super-users” places an inordinate demand on our local EMS system. Emergency health-care stakeholders should make efforts to coordinate preventative care and seek alternatives to use of the 9-1-1 system to provide these patients with the help they need while also relieving the EMS system of this burden.

155. THE IMPACT OF LEAN SIX SIGMA METHODOLOGY ON OFFLOAD DELAY IN A CANADIAN EMS SYSTEM

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Background: Emergency department (ED) arrival to transfer of patient care continues to significantly impact paramedic operational costs, ED congestion, and the ability for paramedics to provide emergency coverage in their communities. Lean Six Sigma is a methodology commonly used in industry to simplify system processes and improve efficiency. The objective of this study was to examine the im-

act of Lean Six Sigma strategies on offload delay times in a Canadian EMS system. **Methods:** We conducted a before and after study in a large community hospital ED with historically high offload delay times. Front-line stakeholders, including paramedics, nurses, physicians, and management, participated in the Lean Six Sigma formal approach to process improvement. Key performance metrics and mean offload delay times were collected before (January 1–December 31, 2011) and after (January 1–June 30, 2012) implementation of Lean Six Sigma strategies. **Results:** Mean (SD) offload delay time decreased from 53.5 (56.0) minutes before the Lean Six Sigma intervention to 40.3 (32.1) minutes (delta 13.2 min; 95% CI: 12.1, 14.2; 25% decrease) in the post-implementation phase. Similarly, 90th percentile offload time decreased from 109.3 min to 74.9 min in the after phase (delta 34.4 min; 95% CI: 29.3, 38.6; 31% decrease). Individual components of offload delay that showed the most improvement post implementation of Lean Six Sigma findings were time to transfer of care (51.4 vs. 19.0 min; delta 32.4 min; 63% decrease), time to registration (9.0 vs. 7.0 min; delta 2.0 min; 22% decrease), and time to paramedic ED departure (40.5 vs. 35.3 min; delta 5.2 min; 13% decrease). Based on a mean monthly EMS transport rate of 1,569 patients, process improvements resulted in 344 hours of increased ambulance availability in the community per month. EMS cost savings as a result of process improvements were \$75,336 per month, and \$904,032 per year. **Conclusions:** When employed by EMS agencies and receiving EDs, Lean Six Sigma methodology may result in significant reductions in ambulance offload delay times. Further study is required to determine whether these findings can be sustained over time and replicated in other EMS systems.

156. CHARACTERISTICS OF THE MOST FREQUENT “SUPER-USERS” OF EMERGENCY MEDICAL SERVICES

Stephen Sanko, Marc Eckstein, Keck School of Medicine, Los Angeles Fire Department

Background: A small group of “super-users” account for a disproportionate number of emergency medical service (EMS) encounters and transports. These patients receive more sporadic, uncoordinated care at disparate sites, leading to redundant testing, high system costs, and ultimately ineffective care plans. The objective of our study was to describe the demographic attributes and diversity of transport destinations of the most frequent users in our large urban EMS system. **Methods:** A retrospective review of electronic medical records from the Los Angeles Fire Department (LAFD), the EMS provider for a city of 3.8 million people, identified the 40 most frequent EMS users from July 2011 to June 2012. Patient demographics, living situation, insurance status, and hospital destination information were collected. **Results:** During the 12 months under study, LAFD providers responded to approximately 336,000 incidents, resulting in 204,900 patient transports. The top 40 EMS “super-users” accounted for 2,359 separate EMS incidents, resulting in 2,209 transports (1% of all system transports). The mean age of this group was 51 years (range 35-65). 30 (75%) patients were male, 26 (65%) were identified as homeless, and 22 (55%) had a history of alcohol abuse. 32 (80%) had some form of insurance, including 23 (58%) with Medi-Cal (California Medicaid) and 7 (18%) with Medicare. These 40 patients were transported to 65 area hospitals, and each patient was transported to a mean of 10 different hospitals over the study period (range 3-22). **Conclusions:** A distinct group of “EMS super-users” accounted for an inordinate

number of ambulance transports. These individuals were predominately male, homeless, and alcohol abusers, and the majority of them have some form of health insurance. Efforts should focus on the creation of sobering centers with immediate referral to detoxification programs, and the assignment of these patients to “home” hospitals.

157. INTERFACILITY TRANSPORTS BETWEEN EMERGENCY DEPARTMENTS UTILIZING THE 9-1-1 EMS SYSTEM

Shira Schlesinger, Stephen Sanko, Marc Eckstein, Keck School of Medicine, UCI Medical Center

Background: With increasing development of specialty centers and regionalization of care, emergency physicians (EPs) are often confronted with patients needing definitive care that is unavailable at their hospital. In these cases, the traditional interfacility transport (IFT) is a useful tool; but may also delay care by hours. Since 2007 the City of Los Angeles has implemented a policy permitting IFTs between emergency departments (EDs) via the 9-1-1 EMS system. Any EP may initiate ED-to-ED IFT based on clinical judgment. **Objective:** To determine the frequency and nature of IFTs provided by the local 9-1-1 EMS system and to evaluate the appropriateness of this use of EMS resources. **Methods:** Retrospective review of all paramedic reports for ED-to-ED IFTs between April 2007 and February 2013 in Los Angeles. All IFTs initiated by call to 9-1-1 from an ED and performed by Los Angeles Fire Department paramedics were included. Transferring and receiving hospital, reason for transfer, patient descriptors, and time metrics were captured, including time on scene, response, transport, and turn-around times. **Results:** There were 729 IFTs via 9-1-1 EMS system during the study period, comprising 0.06% of all EMS calls. The most frequent reason for IFT was for transport of patients with ST segment elevation MI (STEMI) to a STEMI center (59.0%, N = 430), followed by major trauma (12.5%, N = 91), and intracranial hemorrhage (8.1%, N = 59) to trauma and neurosurgical centers. Less common reasons included aortic dissection transferred for vascular surgery (4.4%, N = 32), CVA transported to a stroke center (3.7%, N = 27), obstetric emergencies (3.7%, N = 27), and transfers to pediatric critical care facilities (2.7%). Median transport time was 8 minutes (IQR 6-13 minutes) and median turn-around time was 50 minutes (IQR 39-67 minutes). All IFTs involved a potentially life-threatening condition, requiring a higher level of care than was available at the referring hospital. **Conclusions:** Emergency IFTs via 9-1-1 contact are an infrequent but appropriate use of local EMS resources that increase speed of transfer to definitive care. With an increase in the designation of specialty centers, EMS providers should have procedures in place to handle these requests.

158. THE OFFLOAD ZONE AS A SOLUTION TO EMERGENCY MEDICAL SERVICES (EMS) OFFLOAD DELAY IN THE EMERGENCY DEPARTMENT: A PROCESS MAP AND HAZARD ANALYSIS

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Background: Offload delay is a prolongation of the interval between ambulance arrival in emergency department (ED) and transfer of patient care. This reduces the availability of ambulances for emergency response in the community. The offload zone (OZ), which can receive multiple ambulance patients waiting for an ED bed, has been implemented as a

possible solution. The objectives of this study were to process map the functioning of the OZ and conduct a hazard analysis to identify steps that could compromise patient safety or process efficiency. **Methods:** A Health Care Failure Mode and Effect Analysis was conducted. All major processes and steps were identified by observation and expert opinion. Hazard analysis was conducted by focus group. Failure modes (FM) were identified for each step. For each FM a probability to occur (1-4) and severity of impact on patient safety and process efficiency (1-4) were determined and a hazard score (probability \times severity: 1-16) was calculated. Any hazard score = 8 was considered 'high risk.' Root causes were identified for all 'high-risk' FM. A hazard score was calculated for those causes. Mitigations were sought for 'high-risk' causes with no control measure. **Results:** The process consists of 6 major processes: (1) patient transported by ambulance, (2) arrival in ED, (3) transfer of patient care, (4) patient assessment in OZ, (5) patient care in OZ, and (6) patient transfer out of OZ to ED. There were 110 steps within these major processes categorized as decisions ($n = 13$, 11.8%), skills ($n = 29$, 26.4%), and tasks ($n = 68$, 61.8%). 78 FM were identified, of which 28 (35.9%) were 'high risk': patient safety ($n = 7/28$, 25.0%), process efficiency ($n = 10/28$, 35.7%), and both ($n = 11/28$, 39.3%). 57 causes for 'high risk' FM were identified of which 37 were 'high risk' with no control measure. 17 mitigations were suggested for those 'high-risk' causes with no control measure. **Conclusions:** This process map and hazard analysis has prospectively identified a number of potential failures of the OZ. The results from this study will inform current policy and practice and future work to understand the use of the OZ to reduce offload delay.

159. THE EFFECTS OF REGIONAL EMERGENCY DEPARTMENT OVERCROWDING ON THE ACCEPTANCE OF INTER-HOSPITAL TRANSFER REQUESTS

Sung Wook Song, Hyun Wook Ryoo, Kyoung-Jun Song, Sang Do Shin, Jeju National University Medical Centre

Background: The purpose of this study was to investigate the relationship between the ED overcrowding index of the major receiving hospitals and the acceptance of inter-hospital transfers in a metropolitan city of Korea. **Methods:** A retrospective cross-sectional study was done in a metropolis (2.8 million citizens) with an emergency medical information center (EMIC) responsible for arranging interhospital transfer requests and five tertiary care hospitals receiving most of the interhospital transfer requests. We gathered acceptance of interhospital transfer requests from the interhospital transfer registry of the EMIC. We also collected hourly total ED volume of five major hospitals from the national ED information system (NEDIS). Multivariate logistic regression was used for the association of the interhospital transfer refuse and hourly occupancy rate was adjusted for covariates (gender, age, level/department of request hospitals, weekday and night). **Results:** Between January 1 and May 31 of 2012, there were 1,236 interhospital transfer requests to the EMIC and 2,818 calls to arrange by EMIC. Among a total of 2,818 arranging calls, EMIC arranged 931 (41%) calls successfully. Interhospital transfer refuse rate was increased by increasing the hourly ED occupancy rate of the five major hospitals (adjusted odd ratios [aORs] 2.782, 95% confidential intervals [CIs] 1.333-5.803, $p = 0.006$). **Conclusions:** Acceptance of interhospital transfers was associated with the overcrowding index of the major receiving hospitals in the community. Future studies need to assess the overcrowding

state of the community level and to develop the well-defined regional overcrowding index.

160. THE DEMAND FOR EMERGENCY CARE: SUPPLY OF EMS PROVIDERS AND THE GENERAL POPULACE

Melissa Bentley, Jennifer Eggerichs, Severo Rodriguez, Remle Crowe, National Registry of EMTs

Background: As the population ages the demand for emergency care is increasing. Public expectations dictate that emergency care should be available to all at a moment's notice, yet the supply of emergency physicians and nurses has not kept pace with this demand. Further, little is known about the supply of emergency medical services (EMS) providers in the United States. **Objective:** To describe the number of EMS professionals per 10,000 members of the general populace. **Methods:** To estimate the number of individuals in the United States, the most current population estimates were obtained from the Census Bureau. To obtain these estimates, the Census utilizes the enumerated population for each state from the most recent census (2010) and accounts for estimated rates of births, deaths, and international migration. At the time of this study, state population estimates were available for July 1, 2012. To obtain the number of EMS providers, data were utilized from a June 13, 2012 publication from the National Registry of EMTs (NREMT). As the NREMT is a registry of only nationally certified EMS professionals, only those states that require both initial and national recertification to maintain a state EMS license were included in this study. Estimates of the number of EMS providers are reported by level and per 10,000 state populace. **Results:** Eight states require both initial and national recertification. The average total number of providers was 28.7/10,000 state populace (range: 11.4-46.4). With respect to certification level, the average number of first responders was 1.6/10,000 state populace (range: 0.02-5.4), EMT-basics was 19.5/10,000 state populace (range: 5.2-34.8), EMT-intermediates was 2.5/10,000 state populace (range: 0.3-10.5), and paramedics was 5.1/10,000 state populace (range: 2.8-6.4). **Conclusions:** This study described the four national levels of EMS professionals related to state populace. Future research should focus on comparing the provider-population ratio to other key performance indicators in EMS systems and determining how EMS professionals can be utilized effectively to fulfill the public's need for access to emergency care.

161. PENETRANCE OF BRAIN TRAUMA FOUNDATION GUIDELINES IN THE PREHOSPITAL SETTING: A SYSTEMATIC PROTOCOL REVIEW

Dustin LeBlanc, Jason McMullan, Michael Steuerwald, Michael Bohanske, Kelly Thomas, Joshua Lyons, Stewart Wright, University of Cincinnati

Background: In 2007 the Brain Trauma Foundation released the second edition of Guidelines for Prehospital Management of Traumatic Brain Injury, which sought to optimize management for the brain-injured patient through a systematic approach of assessment, treatment, and decision making. Implementation of these guidelines is considered an effective means of improving outcomes in TBI patients. This study aims to assess the penetrance of specific BTF guidelines (individual components and composite) within a broad sampling of EMS agencies' protocols. We hypothesize that there has not been universal adoption of the BTF guidelines into EMS protocols. **Methods:** A purposeful sampling of 61 protocols from across the United States was performed, rep-

resenting a mixture of individual, county, regional, and state jurisdictions, all regions of the country, and fire-based and third-service agencies. All protocols were last revised in 2011 or 2012. A 23-question evaluation tool was created through an iterative process by EMS and emergency medicine physicians, including an expert in guideline implementation. Each item of the tool was based on the principles of assessment and treatment of the TBI patient from the BTF guidelines and determined to be present or absent after review of the entire protocol set. Protocols were scored by one of five reviewers after training and practice in administration of the tool. Microsoft Excel/Apperson DataLink Connect was used for descriptive data analysis. **Results:** The data reveal a significant deficit in the penetrance of the BTF guidelines into protocols. Of the 61 protocols, initial GCS measurement was specified in 40 (66%), ET_{CO} monitoring recommended in 45 (74%), and hypotension defined in 50 (82%). Additionally, 34 (55%) state to avoid hyperventilation except if signs of herniation are present, 14 (23%) define an ET_{CO} goal of 30-35 mmHg when hyperventilating, and 5 (8%) recommend cessation when clinical signs have improved. None of the protocols assessed incorporated all the elements of the BTF guidelines. **Conclusions:** Despite more than four years since publication of BTF prehospital guidelines, incorporation into prehospital treatment protocols still lags behind, with several key issues needing widely increased adoption.

162. USE OF A SCORING AID IMPROVES GCS SCORING BY EMS PROVIDERS

Amanda Feldman, Kimberly Hart, Christopher Lindsell, Jason McMullan, University of Cincinnati

Background: The Glasgow Coma Scale (GCS) score assigned by emergency medical services (EMS) in the prehospital setting is frequently used in the triage of traumatically injured patients. There is concern, however, that these assessments are not accurate. **Objective:** To assess if prehospital providers can accurately determine GCS using standardized, written scenarios and to determine whether a scoring aid improves accuracy. **Methods:** This study was conducted in the emergency department (ED) of an urban, academic level 1 trauma center. Subjects were emergency medical technicians or paramedics who had transported a patient to the ED; subjects were only allowed to participate once. Participants were randomly assigned one of nine scenarios to score, either with or without a scoring aid. The nine different scenarios were selected and official scores assigned by attending emergency medicine, EMS, and neurocritical care physicians and included mild, moderate, and severe GCS scores. Chi-square and Student t-tests were used to compare groups. **Results:** Of 180 participants, 2 were excluded due to incomplete GCS scores. For the remaining 178 participants, mean age was 36 (SD 9), 83% were white, 88% were male, and 52% were paramedics. Most (70%) reported refresher training on GCS within the past year. Overall, participants scored the GCS correctly 41% of the time, while 28% erred by one point and 31% erred by two or more points. Among participants who did not receive the scoring aid, GCS was correct in 22/88 (25%) of cases and in those who did receive the aid, the GCS was correct in 51/90 (57%) of cases ($p < 0.0001$). The difference in accuracy was most pronounced in GCS 3-12 scenarios. Sub-component accuracy was as follows: eye 62%, verbal 70%, and motor 51%. Twelve participants gave a sub-component score outside of the acceptable range of the scale. **Conclusions:** In this study, the use of a scoring

aid significantly improved EMS accuracy of scenario-based GCS scoring. Even with an aid, however, accuracy remained poor, especially among lower GCS scores and within the motor component.

163. THE ACCURACY OF PREHOSPITAL PROVIDER OXYGEN SATURATION AND END-TIDAL CO₂ DOCUMENTATION IN SEVERE TRAUMATIC BRAIN INJURY

Ben Bobrow, Madalyn Karamooz, Annemarie Silver, Nathan Heagerty, Aaron Dunham, Martha Nunez, Robyn McDonald, David Kasel, Daniel Spaite, University of Pennsylvania, ZOLL Medical Corporation

Background: The prevention of secondary brain injury by EMS providers is critically important to traumatic brain injury (TBI) outcome. Mortality increases 2- to 6-fold with hyperventilation and doubles with a single episode of hypoxia (SpO₂ < 90%). The Brain Trauma Foundation TBI guidelines recommend frequent (q5 min) assessment and documentation of patient vital signs, including SpO₂ and ET/CO₂ (in intubated patients); however, continuous monitoring may be more reflective of the physiology. We aimed to compare the accuracy of EMT documentation compared with continuous SpO₂ and ET/CO₂ recording by the monitor. **Methods:** Patient care reports (PCRs) and monitor (ZOLL E Series) files were collected during the treatment of TBI patients by 2 EMS agencies participating in the EPIC-TBI (Excellence in Prehospital Care-Traumatic Brain Injury) study in Arizona between 10/12 and 5/13. Inclusion criteria: head trauma with potential to have caused brain injury and GCS = 12, GCS < 15 with decreasing GCS or increasing confusion, multisystem trauma requiring intubation, and/or post-traumatic seizures. ET/CO₂ and SpO₂ documented by providers were compared to actual monitor records. **Results:** 34 TBI cases were included (mean age = 40 ± 20 years, 62% male, mean initial GCS = 9 ± 4). In 8/34 cases (24%), vital signs were documented every 5 min per guidelines. SpO₂ was documented below 90% by providers in 8/33 cases (24%) although, according to the monitor, SpO₂ dropped below 90% in 23/33 cases (70%). Hyperventilation (ET/CO₂ < 35 mmHg) was documented by providers in 4/9 cases (57%) vs. 7/9 (78%) according to the monitor. Notably, ET/CO₂ was not documented for 2 patients with ET/CO₂ < 35 mmHg according to the monitor. **Conclusions:** Hypoxia and hypocarbia are very common during the management of severe TBI. Furthermore, the presence of these conditions is significantly under-reported with EMS documentation of visually obtained measurements. Since identification and rapid correction of hypoxia and hyperventilation are critical to TBI outcomes, continuous monitoring may be required to optimize the care of these patients.

164. SUCCESSFUL RETRIEVAL OF ELECTRONIC DATA RECORDER INFORMATION FOR THE CIREN DATABASE

Thomas Hartka, Mark Sochor, Craig Hirsch, Gerald Poplin, University of Virginia

Background: The CDC has included vehicle telemetry data in their most recent national trauma triage protocol for EMS response to automobile collisions. However, due to technological constraints, obtaining and utilizing these data is often difficult or impossible. This study aimed to assess the change in prevalence and availability of Electronic Data Recorder (EDR) data, and to explore the potential usefulness and validity of these data for EMS by reviewing cases from the Crash Injury Research and Engineering Network (CIREN). **Methods:** In total, 3,658 CIREN cases were reviewed for

the years 2001-2012. Each record was assessed to determine if relevant and valid EDR data were available for review. A two-sample test of proportions was performed to assess for the mean difference in EDR cases between two 6-year periods. We also performed a simple linear trend analysis, regressing the proportions by year. **Results:** The mean proportion of cases with EDR in the first and second 6-year time blocks was 0.105 and 0.1883, respectively, reflecting a meaningful but non-statistically significant increase in the percentage of case vehicles with EDR data ($p = 0.6833$). When assessing linear trend, we observed a significant increase in the proportion of cases with EDR data available in the CIREN database, trending from 1% to 33% of cases over time ($p = 0.001$). This result is consistent with our finding that an increasing proportion of newer vehicles in CIREN had EDR data extracted over the same time period, with 45% recovery for 2012 CIREN case vehicles compared to 13% for 2001 vehicles. **Conclusions:** Vehicle telemetry is increasingly being recorded in newer vehicles and has the potential to provide important information for EMS assessment, triage, and field management. This study demonstrates that both the availability and the post-crash recovery of crash-related EDR data have been increasing over the previous past 12 years. Standardization of technology to facilitate EDR data transfer will be an important step toward its effective utilization by EMS, increasing the efficiency of EMS response, and assessment.

165. CHARACTERISTICS OF TRAUMA PATIENTS WITH POTENTIAL CERVICAL SPINE INJURIES OVER-IMMOBILIZED BY PREHOSPITAL PROVIDERS

Elizabeth Paterek, Derek Isenberg, Drexel University

Background: Immobilization of trauma patients by first responders has undergone significant changes to decrease unnecessary immobilizations. Excess spinal immobilization by first responders can harm patients by increasing discomfort, delaying in transit time, and causing tissue ischemia. Studies have validated the use of clearance criteria by EMS providers to limit unnecessary immobilization, which have been implemented by many EMS systems. Despite clinical criteria for c-spine clearance, EMTs continue to over-immobilize trauma patients. Our goal was to determine the characteristics of patients who were over-immobilized in our EMS system. **Methods:** Our study was a retrospective chart review of a single EMS system from September 1, 2012 to February 28, 2013. We reviewed all calls with a dispatch complaint of "motor vehicle crash" or "fall." We used the Pennsylvania Commonwealth EMS protocol for selective spine immobilization (SSI), which mirror the NEXUS criteria, to determine appropriateness of immobilization. We reviewed the factors leading to over-immobilization of patients. **Results:** Our EMS system responded to 1,151 motor vehicle crashes and falls over the 18-month study period. Of these patients, 76 (6.6%) were immobilized. Of the patients immobilized, 12/76 (15.8%) did not meet immobilization criteria. The reasons for immobilization included, "mechanism of injury" (50%), "head injury" (33%), and "vehicular damage" (17%). Of these patients, 50% were over-immobilized by EMT-Ps and 50% by EMT-Bs. Of the 12 patients who were over immobilized by EMS, 9 (75%) were clinically cleared by the emergency physician, 2 (16%) had a negative CT scan of the neck, and information was not available for 1 (8%). **Conclusions:** A significant number of patients continue to be over-immobilized despite current guidelines for immobilization. 75% of patients who were over-immobilized had no imaging done in the ED. This was a limited

chart review involving only two dispatch categories. We may have missed patients who were under-immobilized from other dispatch categories. In addition, in some cases, we abstracted the criteria for spinal immobilization based on the documentation provided rather than speaking to the treating EMTs. We suggest continued education among EMS providers that use of SSI is safe regardless of mechanism of injury, associated head injury, or vehicle damage.

166. GLASGOW COMA SCALE SCORES (GCS) ARE OFTEN INACCURATE

Bryan Bledsoe, University of Nevada

Background: The Glasgow Coma Scale (GCS) is an assessment tool for measuring the level of consciousness and coma in patients with possible neurologic impairment. The GCS is important in determining whether a patient is improving or worsening as care is provided. Despite standardization, there appears to be significant variation in GCS scoring by various emergency health-care professionals. Such discrepancies can complicate emergency care. The objective of this study was to determine the accuracy of GCS scoring by various levels of health-care professionals given 10 standardized video scenarios. **Methods:** We prepared a video of 10 patient scenarios where GCS scores could be readily determined. The correct GCS score for each of the scenarios was determined by independent scoring by two board-certified neurologists. Inter-rater agreement was perfect ($k = 1.0$). The video was loaded onto iPad tablets and shown to a convenience sample of health-care professionals. Subjects were asked to watch the video non-stop and score the 10 vignettes on paper score sheets. Electronic and visual aids were not permitted. The score sheets requested basic demographic information and the 10 GCS scores (eye opening response [E], verbal response [V], motor response [M], and total GCS score [T]). The score sheets were collected and entered into an Excel spreadsheet for data summation and statistical analysis. **Results:** A total of 217 emergency health-care professionals took part in the study. There were 2,084 total GCS observations with complete data sets for analysis. Overall GCS scoring accuracy was 33.1% (95%CI: 30.2-36.0). **Conclusions:** Only one-third of GCS scores were accurate in this mixed emergency health-care provider cohort. Strategies should be developed to promote improved accuracy of GCS scoring or development of a simpler tool should be considered.

167. TOURNIQUET UTILIZATION PATTERNS AND IMPACTS ON HEMOSTASIS IN A LARGE URBAN EMS SYSTEM

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Background: Combat casualty care education and peer-reviewed manuscripts describing this care as performed in the military conflict theater indicate significant survival benefits from the timely application of tourniquets in the setting of extremity trauma with significant ongoing hemorrhage. There is a paucity of published clinical data regarding the translation of this knowledge into civilian use by emergency medical services (EMS) systems. This study's purpose was to analyze a civilian patient cohort in which tourniquets were utilized as hemostatic intervention in a large, urban EMS system in the southwestern United States. **Methods:** Retrospective chart review of consecutive patient encounters involving use of at least one tourniquet occurring August 1, 2010 to June 1, 2013 in the study EMS system. **Results:** In the 34-month study period, 106 patient encounters

involved application of at least one tourniquet. 83/106 (78.3%) of patients were male. Mean patient age was 40.4 years old, with 10% of patients being 65 years of age or older. The most common injury type was laceration, sustained in 62/106 (58.5%) patients. The second most common indication for tourniquet application was bleeding from a dialysis fistula in 14/106 (13.2%) patients. 80/106 (75.5%) injuries treated were located on an upper extremity, and 74/106 (69.8%) injuries were located in the proximal half of the involved limb(s). In the 80 patients in which pre-tourniquet hemostatic treatment was attempted, the most common option failing to achieve desired hemostasis was direct pressure, utilized in 58/80 (72.5%) of this subgroup. Overall, hemostasis was documented post-tourniquet application as successful in 90/106 (84.9%) patients. Using Fisher's exact test, there was not a statistically significant difference in achieving hemostasis comparing upper to lower extremity location ($p = 0.36$) or comparing distal to proximal injury location ($p = 0.50$). **Conclusions:** In a civilian cohort of patients with extremity injuries treated with tourniquets applied by EMS professionals in a large, urban EMS system, hemostasis was achieved in the large majority. Location of injury and limb(s) involved did not affect likelihood of resulting hemostasis.

168. TOURNIQUET USE IN A CIVILIAN EMERGENCY MEDICAL SERVICES SETTING: A DESCRIPTIVE ANALYSIS OF THE BOSTON EMS EXPERIENCE

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Background: Early use of tourniquets for severe extremity hemorrhage has become standard of care in the military and tactical medical settings. As a result, tourniquet use in the civilian emergency medical services (EMS) setting has become more common. **Objective:** To describe the experience of tourniquet use in a civilian, urban EMS setting. **Methods:** A retrospective chart review of prehospital tourniquet application was performed from January 1, 2005 to December 1, 2012. Data such as the total time duration of tourniquet placement, EMS scene time, mechanism of injury, and patient demographics underwent descriptive analysis. Hospital data available for patients presenting specifically to Boston Medical Center were also reviewed. Statistical significance level was set at $p < 0.05$. **Results:** Ninety-eight cases of prehospital tourniquet use were identified. The most common causes of injury requiring a tourniquet were penetrating gunshot or stabbing wounds (67.4%, 66/98). 7.1% (7/98) of

cases were due to blunt trauma. 22.5% (22/98) of cases were from non-traumatic injuries related to uncontrolled hemodialysis shunt or wound bleeding. 73.5% (72/98) of cases were placed on a lower extremity. 25.5% (25/98) were placed on an upper extremity. The mean total time of tourniquet placement was 14.9 minutes. The mean EMS scene time was 10.7 minutes. 50% of tourniquets were placed by a BLS provider. Four patients were in cardiac arrest prior to EMS arrival, 1 from blunt trauma and 3 from bleeding hemodialysis fistulas, of which 1 had prehospital return of spontaneous circulation. Hospital follow-up was available for 61.2% (60/98) of all cases reviewed. Of these cases, the tourniquet was removed by EMS in 5% (3/60), the emergency department in 50% (30/60), and in the operating room (OR) in 30% (18/60) of the time. 61.7% of cases going to the OR documented a major vessel injury. Overall, there were 7 deaths, none of which were due to tourniquet use. There were no documented cases of nerve injuries or long-term complication after tourniquet use. **Conclusions:** In an urban EMS setting, the early use of tourniquets for extremity hemorrhage appears to be safe, with complications occurring infrequently.