

NAEMSP ABSTRACTS

ABSTRACTS FOR THE 2016 NAEMSP SCIENTIFIC ASSEMBLY

Oral Abstracts

1. COMPARISON OF THE PERFORMANCE OF PREHOSPITAL SYSTOLIC BLOOD PRESSURE VS. CALCULATED MEAN ARTERIAL PRESSURE IN PREDICTING MORTALITY IN MAJOR TRAUMATIC BRAIN INJURY

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Background: The current prehospital treatment guidelines for Traumatic Brain Injury (TBI) utilize systolic blood pressure (SBP) to identify hypotensive patients and to guide fluid resuscitation. Despite this, the Guidelines explicitly state that calculated mean arterial pressure (MAP) may be superior to SBP for assessing perfusion and call for studies to compare their performance as risk-adjustment measures in TBI. However, no large prehospital investigations have occurred to evaluate this issue. We compared the performance of prehospital SBP to MAP in predicting mortality among major (moderate/severe) TBI patients in a statewide, multisystem study. **Methods:** All major TBI cases (CDC Barell Matrix Type-1) in the pre-implementation cohort of the Excellence in Prehospital Injury Care (EPIC) TBI Study (NIH/NINDS-1R01NS071049; ClinicalTrials.gov:NCT01339702) (1/1/07-3/31/14) with a lowest prehospital SBP between 40-300 mmHg and lowest MAP 30-200 were included (exclusions: age10+, inter-hospital transfers, missing SBP/MAP, or other risk adjusters). Logistic regression was used to predict mortality. Ten-fold cross-validation was used to calculate the area under receiver operating characteristic curve (AUC) and to compare the predictive power of SBP vs. MAP. Three models were used: 1) unadjusted; 2) partially-adjusted for subject characteristics, trauma type and hypoxia (risk-adjusters available to EMS providers in real-time); 3) fully-adjusted, that further adjusts for injury severity score (ISS), ICD-Head severity score, prehospital intubation, payer source, and trauma center. **Results:** A total of 8,627 subjects were included with 893 deaths. When rendered visually, SBP and MAP perform so similarly that the AUC plots are indistinguishable from

each other. **Comparisons:** Unadjusted: SBP = 0.657 (95%CI: 0.636-0.678) vs. MAP = 0.651 (0.631-0.672); partially-adjusted: SBP = 0.788 (0.770-0.805) vs. MAP = 0.787 (0.769-0.804); fully-adjusted: SBP = 0.955 (0.950-0.961) vs. MAP = 0.955 (0.950-0.961); all p-values above 0.4). **Conclusions:** In major TBI, lowest prehospital SBP and lowest calculated MAP performed nearly identically as predictors of mortality risk in the unadjusted, partially-adjusted, and fully-adjusted models. The fully-adjusted models performed exceptionally well as predictors for mortality (AUC = 0.955 for both SBP and MAP). Given the very large study size and the inclusion of highly-diverse EMS systems, these findings support the use of SBP in guiding the prehospital management of TBI as it is simpler and far more practical than utilizing calculated MAP in the prehospital setting.

2. PREHOSPITAL INTUBATION IN THE PEDIATRIC PATIENT ACROSS AN ENTIRE STATE

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Background: Pediatric endotracheal intubation (PETI) is considered standard for advanced life support personnel by many professional organizations even though national success rates range from 74-79%. Although PETI is a potentially lifesaving procedure, it can be challenging, with failed airways delaying definitive emergency care and increasing morbidity and mortality. The incidence and success rates of PETI across state EMS systems are not well described. This study reports the incidence and success of PETI by EMS in an entire state. **Methods:** This is a retrospective review of the EMSPIC (EMS Process Improvement Center) database from 7/2013-7/2014. This system is used by over 700 EMS agencies. Children <18 years old requiring EMS transport by a primary 9-1-1 service were included. PETI incidence was determined by identifying the proportion of children intubated by EMS personnel in the prehospital setting per 100,000 population in urban and rural areas. Overall and 1st time success rates were determined. Incidence and success rates of PETI were compared in urban and rural areas and in infants (<1 year old) compared to older children using Z tests for proportions. **Results:** Over the study period 175 pediatric patients were intubated by EMS providers in the prehospital setting, with 31% (54/175) occurring in rural areas and 69% (121/175) in urban areas. Infants accounted for 31% (55/175) of intubations. Pediatric intubations occurred more frequently per 100,000

population in a rural setting compared to an urban setting (2.5 per 100,000 v. 1 per 100,000, respectively). There was no difference in rural vs. urban PETI success rates (65% [95%CI: 50-78%] v. 73% [95%CI: 64-81%]) or 1st attempt success rates (58% [95%CI: 43-72%] v. 52% [95%CI: 42-61%]). There was also no difference in success rates among infants compared to older children (65% [95%CI: 52-77%] v. 75% [95%CI: 64-83%]). **Conclusion:** Across the state studied, PETI by EMS occurs more frequently per population in a rural setting. There are no significant differences in PETI success rate or 1st attempt success rate based on rurality or age. Compared to national averages, the low overall success rates and 1st attempt success should lead to increased consideration of bag valve mask use for pediatrics.

3. A LARGE RANDOMIZED TRIAL OF CONTINUOUS VS. INTERRUPTED CHEST COMPRESSIONS IN OUT-OF-HOSPITAL CARDIAC ARREST: RESULTS OF THE RESUSCITATION OUTCOMES CONSORTIUM CCC TRIAL

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Background: Interruptions in manual chest compressions occur frequently during treatment of out-of-hospital cardiac arrest (OHCA), potentially impacting blood flow and patient outcomes. The objective of this large multicenter randomized controlled trial was to compare the effects of continuous chest compressions (CCC) vs. chest compressions with interruptions for ventilations (ICC) upon hospital survival and neurological status after OHCA. **Methods:** This multicenter randomized trial (ClinicalTrials.gov registration NCT01372748) included 112 emergency medical services (EMS) agencies associated with the Resuscitation Outcomes Consortium (ROC). Subjects included adult non-traumatic OHCA receiving chest compressions from dispatched EMS providers. EMS agencies or stations were cluster randomized to study interventions with periodic cross-over. The study interventions were: 1) continuous chest compressions with positive pressure ventilations without pauses (intervention group - CCC), and 2) chest compressions with interruptions for ventilations at a ratio of 30 compressions to 2 ventilations (con-

trol group - ICC). Subjects were enrolled from June 6, 2011 to May 28, 2015. The primary outcome was survival to hospital discharge. The secondary outcome was hospital survival with good neurologic status (Modified Rankin Scale (MRS) ≤ 3). The trial used continuous CPR process measurements to assess study treatment compliance. We analyzed the data using t-tests with determination of associated risk differences and 95% confidence intervals. **Results:** Of 23,698 patients included in the primary analysis, 12,647 were randomly assigned to CCC and 11,051 to ICC. As of June 14, 2015, vital status was available on 23,485 (99.1% of enrolled.) Survival to hospital discharge did not differ between CCC and ICC (8.8% vs 9.6%; risk difference -0.71% [95% CI: $-1.60, 0.10\%$]; $p = 0.07$). Survival to hospital discharge with MRS ≤ 3 did not differ between CCC and ICC (6.9% vs. 7.6%; risk difference -0.66% [95% CI: $-1.44, 0.12\%$]; $p = 0.10$). **Conclusion:** In this large multicenter randomized trial, hospital survival and neurologic status did not differ between continuous chest compressions and chest compressions with interruptions for ventilations.

4. EVALUATING CLINICAL CARE IN THE PREHOSPITAL SETTING: IS REMS THE MISSING METRIC OF EMS?

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Background: The determination of patient acuity in the prehospital setting is not standardized and is challenging to appreciate for individuals responsible for system oversight. Metrics exist for specific diseases; however, there is no uniform tool to evaluate all patients. The Rapid Emergency Medicine Score (REMS) was developed to predict emergency department patient mortality. This score has potential applications within EMS. Our objective was to utilize REMS to assess initial patient acuity and evaluate clinical change during prehospital care. Additionally, we described the relationship between dispatch and transport priorities with REMS. **Methods:** All non-cardiac arrest emergency transports from April 1, 2013 to March 31, 2014 were analyzed from a single ALS municipal EMS agency. Using age, mean arterial blood pressure, heart rate, respiratory rate, oxygen saturation, and the Glasgow Coma Score, initial and final REMS were calculated based on prehospital data. REMS varies between 0–26 with higher scores indicating increased probability of mortality. Change in REMS was calculated by initial minus final with a positive number indicating clinical improvement. Descriptive analyses were performed calculating means and 95% confidence intervals, and stratified by dispatch and transport priorities. **Results:** There were 61,346 patients analyzed with an average initial REMS of 4.3 (95% CI: 4.2–4.3) and an average REMS change of 0.37 (95% CI: 0.36–0.38). Those patients classified with the highest dispatch priority had the highest initial REMS (5.8; 95% CI: 5.5–6.2) and the greatest change (0.95; 95% CI: 0.72–1.17). Patients transported with high priority had greater initial REMS, as well as greater improvement in REMS (high priority 7.3 [95% CI: 7.1–7.4], change 0.61 [95% CI: 0.53–0.69]; middle priority 5.3 [95% CI: 5.2–5.4], change 0.55 [95% CI: 0.51–0.59]; low priority 3.9 [95% CI: 3.8–3.9], change 0.32 [95% CI: 0.31–0.33]). **Conclusion:** Descriptive analyses indicate that as dispatch and transport priorities increased in severity so too did initial REMS. The largest change in REMS was seen in patients with the highest dispatch and transport priorities. This indicates that REMS may provide system level insight into evaluating clinical changes during patient care. Further research is needed to determine

the strength of these associations and presence of confounding variables.

5. END TIDAL CARBON DIOXIDE IS NOT A GOOD PREDICTOR OF COMPRESSION DEPTH OR BLOOD FLOW DURING CPR

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Background: End tidal carbon dioxide (ETCO₂) has been proposed as an indicator of chest compression (CC) quality and as a surrogate of blood flow. Monitoring of ETCO₂ has, therefore, been suggested as a tool to personalize CPR during cardiac arrest. We investigated the sensitivity of ETCO₂ as a metric for CC quality (depth and duty cycle) and cardiac output. **Methods:** CPR was performed on 30 domestic swine (~30 kg) using standard physiological monitoring. Flow was measured in the inferior vena cava (IVC). Ventricular fibrillation (VF) was electrically induced. Mechanical CC was started after ten minutes of VF. CC were delivered at a rate of 100 compressions per minute with duty cycles of 33, 50, 58, and 68% and at depths of 32, 38, and 51 mm for a total of 54 min. **Results:** In the first 20 min of CPR, ETCO₂ values had a wide range at each depth. During 2" CC, the interquartile range encompassed ETCO₂ values in the range of 20–40 mmHg. After 30 min of CPR, a 33% duty cycle resulted in a significantly greater ETCO₂ as compared to the other duty cycles (23.6 ± 8.1 vs. 8.8 ± 7.7 mmHg, $p = 0.05$). **Conclusions:** During CPR, a wide range of ETCO₂ values were observed at different CC depths with the largest range observed at a depth consistent with guideline compliant CPR. ETCO₂ measures can be increased by modifying the chest compression waveform, but this does not result in a concomitant increase in blood flow. These data indicate that ETCO₂ is an unreliable metric of CPR quality and CC generated blood flow, which suggests it may not be a suitable physiologic metric to guide personalized CPR.

6. HYPOGLYCEMIA PATIENTS TREATED BY PARAMEDICS AND PREDICTORS OF HOSPITAL ADMISSION

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Background: In Ontario, there currently are no prehospital treat-and-release protocols and the safety of this practice remains unclear. The objectives of this study were to describe the characteristics, management, and outcomes of hypoglycemic patients treated by paramedics, and to determine the predictors of hospital admission for these patients. **Methods:** We performed a health record review of paramedic call reports (PCR) and Emergency Department (ED) records over a 12-month period. We queried prehospital databases to identify cases, which included all patients <18 yrs with a prehospital glucose reading of $<72\text{mg/dL}$ (4.0 mmol/L) and excluded terminally ill and cardiac arrest patients. We developed and piloted a standardized data collection tool and obtained consensus on all data definitions before initiation of data extraction by a trained investigator. Data analyses include descriptive statistics, Chi-square, t-tests, and logistic regression with adjusted odds ratios (AdjOR). **Results:** There were 804 patients with the following characteristics: mean age 55.1, male 52.4%, type1 diabetes 11.6%, on insulin 44.4%, mean initial glucose 50 (2.8), from home 56.9%,

13.4% treated by paramedics for hypoglycemia in the last 90 days. They were treated by an Advanced Care Paramedic 82.4%, received IV D50 38.4%, IM glucagon 16.7%, PO complex carbs/protein 26.6%, and accepted transport to hospital 70.4%. Of those that were transported, 122 (21.6%) were admitted, of those 36 (29.5%) were admitted due to hypoglycemia, and 8 (1.4%) died in the ED. A higher proportion of admitted patients were on beta-blockers (32.3% vs. 15.3%, $p < 0.001$) and oral hypoglycemic agents (28.5% vs. 18.4%, $p = 0.011$). Patients on corticosteroids, or those given glucagon on scene were most likely to be admitted to hospital (AdjOR 3.8; 95%CI 1.8–8.1, AdjOR 2.7; 95%CI 1.62–4.66), and those taking insulin or tolerating PO complex carbs/protein (AdjOR 0.28; 95%CI 0.16–0.48 and 0.30; 95%CI 0.14–0.62) were less likely to be admitted. **Conclusions:** Patients taking insulin or able to tolerate PO complex carbs/protein in the field are less likely to be admitted to hospital while patients on corticosteroids or given glucagon are more likely. These findings will contribute to the development of a safe treat-and-release strategy that could greatly influence practice in paramedicine.

7. HEMOSTATIC DRESSINGS FOR EXTERNAL BLEEDING: A SYSTEMATIC REVIEW USING GRADE METHODOLOGY

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Background: Effective management of severe external bleeding is an important component of first aid and emergency care. Hemostatic agents and dressings have been used by the military as an additional means to control severe bleeding; their use is becoming more common in the civilian sector. The objective is to summarize the evidence for use of topical hemostatic dressings for severe external bleeding in first aid and emergency care. **Methods:** This International Liaison Committee on Resuscitation (ILCOR) First Aid systematic review informed the 2015 Consensus on Science and Treatment Recommendations. Two investigators followed GRADE methodology. Structured search strategies were executed in PubMed, EMBASE, and Cochrane, with hand-searching of reference lists, recent review articles and 2010 worksheets. Articles were included by consensus. Study quality assessments were independently completed by two investigators. Outcomes were identified a priori: mortality (critical outcome), hemostasis (critical), complications (critical), and time to bleeding cessation (important). Data was pooled using GRADEpro software, and reported descriptively. **Results:** The electronic database search retrieved 1,237 citations and the hand-search retrieved 19. After review of titles and abstracts, 81 full text articles were reviewed, and 12 articles were included: four human case series studies (three from a military/war setting and one from civilian EMS) and eight animal studies (seven were randomized trials). An total of 24% (27/112) of subjects who received hemostatic dressings died, compared to 66% (54/82) who did not receive hemostatic dressings (very low quality evidence). Hemostasis occurred in 88% (141/161) of subjects, compared to 50% (13/26) of those who did not receive hemostatic dressings (very low quality). Complications from hemostatic dressings occur in 3% (3/96) of subjects (no comparison group) (very low quality). A total of 73% (25/34) of subjects achieved hemostasis in under 3 min with a hemostatic dressing applied (no comparison group) (very low quality). **Conclusion:** These dressings may

be effective for rapid hemostasis and lead to reduction in mortality. Evidence for the use of hemostatic dressings is largely from low quality animal and uncontrolled descriptive human studies. Further human research is required to determine the clinical effectiveness and safety of hemostatics for severe external bleeding.

8. IV VS. IO EPINEPHRINE IN THE TREATMENT OF OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Guidelines endorse both intravenous (IV) and intraosseous (IO) medication administration for the treatment of cardiac arrest. There is minimal clinical evidence from human trials to support this equivocal recommendation. We compared outcomes in a cohort of out-of-hospital cardiac arrest (OHCA) patients who received parenteral epinephrine from emergency medical services (EMS) providers. **Methods:** This was a structured, retrospective chart review of EMS records. Adult subjects who suffered an OHCA and were treated with parenteral epinephrine by one of 3 EMS agencies over an 18-month period were included in the analysis. Per the regional EMS protocols, the choice of parenteral access type was at the provider's discretion. An intention-to-treat (based on first parenteral access type attempted) and an as-treated (based on the route of administration for the first dose of epinephrine) analysis were performed. The primary outcome was return of spontaneous circulation (ROSC) at time of hospital arrival. **Results:** A total of 1,310 subjects suffered an OHCA and met the inclusion criteria. Providers first attempted parenteral access via the IV route in 788 (60.15%) subjects, and via the IO route in 552 (39.85%) subjects. In the intention-to-treat analysis, rates of ROSC were 19.67% in the IV group and 19.92% in the IO group (OR 1.02; CI: 0.77–1.34). In the as-treated analysis, rates of ROSC at time of hospital transfer were 20.92% in the IV groups and 18.55% in the IO group (OR 0.86; CI: 0.66–1.13). Success in obtaining the first access type (IV or IO) attempted was associated with a 10.84% higher rate of ROSC (OR 1.92 CI: 1.20–3.07). In both analyses, groups were similar in terms of age, bystander witnessed arrest, bystander CPR, and initial shockable rhythms. **Conclusion:** No difference in ROSC was identified when paramedics delivered parenteral epinephrine by IV vs. IO. A prospective, randomized trial may be warranted to clarify the effectiveness of these techniques in OHCA.

9. EVALUATING THE COST AND UTILITY OF MANDATING SCHOOLS TO STOCK EPINEPHRINE AUTO-INJECTORS

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Background: The Michigan Legislature mandated that all public schools stock epinephrine auto-injectors (EAI) and train staff in their use. A minimal amount of data is available regarding the incremental value of EAI in schools, especially in regions with developed EMS systems. Our primary objective was to describe the frequency of administration of epinephrine for EMS patients with acute allergic reactions in public schools. Our secondary objective was to estimate the cost of mandating public schools to stock EAI. **Methods:** We performed a retrospective cohort study of EMS cases with an impression of allergic reaction and who re-

ceived epinephrine recorded in the 2014 Michigan EMS Information System (MI-EMSIS) data set. We excluded responses with incomplete location information. We abstracted records for patient demographics, incident location, source of epinephrine given, and suspected allergen if known. We evaluated the temporal impact of school EAI in locations with a predominant ALS response to emergencies (Defined as 90% of calls receive an ALS response). We estimated the unsubsidized annual cost of this mandate for Michigan public schools ($N = 4,039$), with costs for the required EAI 2-pack as estimated by the legislature (\$140) and commercial sources (\$450). Training costs were not included. Descriptive statistics are reported. **Results:** During the study period there were 5,994 EMS cases with impression of allergic reaction with 487 receiving epinephrine, with 18 public school cases, 15 (83.3%) children, and 3 (16.7%) adults. Reported allergens were most often food 8 (44.4%), insect stings 4 (22.2%), or unknown 4 (22.2%). Among these patients, 7 (38.9%) administered their own EAI, 6 (33.3%) received epinephrine from EMS supply, 2 (11.1%) received epinephrine from school supply, with 3 (16.7%) whose Epi source was unknown. A majority (16, 88.9%) of the public school cases occurred in communities with ALS systems. ALS response in these communities was relatively rapid (median response 6 min, 90%ile, 13 min). The unsubsidized annual cost of Michigan public schools to stock EAI ranges from \$565,460 to \$1,817,550. **Conclusion:** In this study, few public school patients received epinephrine and the vast majority occurred in communities with rapid ALS response. The direct annual supply cost of the school EAI mandate is substantial.

10. IMPLEMENTATION OF A MULTIDIMENSIONAL BUNDLE FOR DISPATCHER-ASSISTED CPR IN A HORIZONTAL DISPATCH SYSTEM IS ASSOCIATED WITH INCREASED BYSTANDER CPR AND GOOD NEUROLOGICAL SURVIVAL FROM OUT-OF-HOSPITAL CARDIAC ARREST

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Background: The resuscitation guidelines indicate pre-arrival dispatcher-assisted telephone CPR (DATCPR) instructions and measurement increase the proportion of bystander CPR (BCPR); however, the impact of those guidelines on survival is not well known. This study is to describe the impact of a comprehensive bundle of DATCPR on BCPR and survival from OHCA in a horizontal computerized-aided dispatch (CAD) system. **Methods:** A centralized CAD system in a metropolitan EMS is studied. Routinely in system, the time from call to ambulance dispatch should be within 60 sec. The audio recordings of confirmed OHCA were reviewed using a standardized format linked with EMS and hospital process and outcome data. The proportions of BCPR and survival six months after implementation (P1) of a bundle that included guideline-based protocol changes, staff training, computerized audit, feedback to providers, and leadership rebuilt are compared with that of the same month period in the prior year as control group (P0), using regression analysis for statistics. **Results:** There were 1437 OHCA [665 P0, 772 P1; 64% male, median age 62 (IQR: 47–74)]. The rate of BCPR went from 20.6% in P0 to 35.0% in P1 ($p < 0.001$). Outcome of ROSC upon hospital arrival was significantly higher in P1 (10.4%) compared to P0 (6.6%, $p = 0.037$), as was good neurological outcome (CPC 1or2: 5.5% in P1 vs. 2.6% in P0, $p = 0.029$). Survival to hospital discharge was higher in P1 (8.3%, vs. P0: 6.4%)

but not statistically significant. After adjusting for witnessed arrest, shockable rhythms, age, sex, and prehospital time intervals, good neurological outcome were still significantly higher in P1 vs. P0 [adjusted odds ratios: 2.1 (95% 1.1–4.4)]. **Conclusions:** The implementation of a comprehensive bundle of DATCPR in a metropolitan horizontal dispatch system was associated with significant improvements in the rates of BCPR and good neurologic outcome after OHCA.

11. INITIAL AMSA AND INCREASED AMSA AFTER CPR PREDICT SECOND SHOCK SUCCESS IN INITIALLY SHOCK-RESISTANT VF DURING OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Amplitude spectrum area (AMSA), which is calculated from the ventricular fibrillation (VF) waveform using fast Fourier transformation, has been recognized as a predictor of successful defibrillation (DF) and as an index of myocardial perfusion and viability during resuscitation. In this study, we investigated whether a change in AMSA occurring during CPR would predict DF outcome for subsequent DF attempts after a failed DF. We hypothesized that a patient responding to CPR with an increase in AMSA would have an increased likelihood of DF success. **Methods:** This was a retrospective analysis of out-of-hospital cardiac arrest patients who received a second DF due to initially shock-resistant VF. A total of 193 patients with an unsuccessful first DF were identified in a manufacturer database of electrocardiographic defibrillator records. AMSA was calculated for the first DF (AMSA1) and the second DF (AMSA2) during a 2.1 sec window ending 0.5 sec prior to DF. A successful DF attempt was defined as the presence of an organized rhythm with a rate ≥ 40 / min starting within 60 sec from the DF and lasting for > 30 sec. After the failed first DF, all patients received CPR for 2 to 3 min before delivery of the second DF. Change in AMSA (Δ AMSA) was calculated as Δ AMSA = AMSA2 – AMSA1. **Results:** The overall second DF success rate was 14.5%. Multivariable logistic regression showed that both AMSA1 and Δ AMSA were independent predictors of second DF success with odds ratios of 1.24 (95% CI 1.12–1.38, $p < 0.001$) and 1.27 (95% CI 1.16–1.41, $p < 0.001$) for each mVHz change in AMSA or Δ AMSA, respectively. **Conclusions:** In initially DF-resistant VF, a high initial AMSA value predicted an increased likelihood of second shock success. An increase of AMSA in response to CPR also predicted a higher second shock success rate. Monitoring of AMSA during resuscitation therefore may be useful to guide CPR efforts, possibly including timing of second shock delivery. These findings also further support the value of AMSA as indicator of myocardial viability.

12. TOURNIQUET APPLICATION FOR LIMB BLEEDING: A SYSTEMATIC REVIEW USING GRADE METHODOLOGY

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Background: Guidelines supporting or opposing the application of tourniquets by first aid and emergency medical services (EMS) providers has fluctuated. Research has been sparse. This review synthesized evidence for prehospital tourniquet application for severe limb bleeding. **Methods:** This International Liaison Committee on Resuscitation (ILCOR) First Aid systematic review informed the

2015 Consensus on Science and Treatment Recommendations. Two investigators followed GRADE methodology. Structured search strategies were in PubMed, EMBASE, and Cochrane, with hand-searching. Articles included by consensus. Study quality assessments were independently completed by two investigators. *A priori*-identified outcomes were: hemostasis (critical outcome), mortality (critical), vital signs (critical), and complications (important). Data was pooled using GRADEpro software, reported descriptively and compared. **Results:** The search retrieved 1,021 citations. After selection of titles and abstracts and full text article review, 13 nonrandomized human studies included: two from the EMS setting, eight from a war setting and three with volunteer subjects. Tourniquets used were a mix of improvised and commercial devices. 83% (35/42) of patients who had a tourniquet applied achieved hemostasis vs. 61% (17/28) that did not have tourniquet (RR 10.54 (6.55–16.96)). 75% (560/750) of case series patients with tourniquet achieved hemostasis. 12% (91/791) of patients who had a tourniquet applied died vs. 9% (89/977) that did not (RR 1.08 (0.82–1.43)). 10% of case series patients with tourniquet died (92/903). No difference was found in vital signs; heart rate mean difference: 3 beats per minute more (0.21–6.91) if tourniquet applied; systolic blood pressure mean difference: 9 mmHg less (–14.13–3.43) if tourniquet applied. 6% (6/67) patients who had tourniquet applied had complications vs. 9% (9/98) without tourniquet (RR 0.19 (0.06–0.55)) and 4% case series patients with tourniquet had complications (36/846). **Conclusion:** Evidence is low quality and heterogeneous, with a mix of patient types, tourniquet types and were applied by those with various levels of training. Tourniquet application may effectively stop bleeding for external limb bleeding. No difference was found in mortality and vital signs. Complications were fewer if tourniquet applied. Further well-controlled studies on tourniquets by first aid and EMS providers are required.

13. INITIAL AND SUBSEQUENT CONVERSION TO SHOCKABLE RHYTHMS DURING RESUSCITATION PREDICTS SURVIVAL FOR OUT-OF HOSPITAL CARDIAC ARREST

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Background: Initial shockable rhythm (ventricular fibrillation/VE, ventricular tachycardia/VT) is a significant predictor of survival-to-discharge for out-of-hospital cardiac arrest (OHCA). However, the prognostic influence of conversion to shockable rhythms during resuscitation for initially non-shockable rhythms remains unclear. **Objective:** This study aimed to assess the relationship between initial and subsequent shockable rhythm and post-arrest survival and neurological outcomes after OHCA. **Methods:** This was a retrospective analysis of adult OHCA cases (≥ 18 years) reported to the Pan-Asian Resuscitation Outcomes Study (PAROS) registry between 2009 and 2012. We included cases that were presumed cardiac etiology, and had resuscitation attempted by EMS. Primary outcome was survival-to-hospital-discharge (discharged alive/remaining in hospital at 30th day post-arrest). The outcomes of OHCA were evaluated based on 3 stratified groups: initial shockable rhythm, subsequent shockable rhythm and remained in non-shockable rhythm. A 2-stage seemingly unrelated bivariate probit model was developed to assess the influence of initial rhythm and

subsequent conversion rhythm on survival-to-admission (1st stage) and survival-to-discharge outcomes (2nd stage). We adjusted for the clustering effects of country variance in all models. **Results:** A total of 40,160 OHCA cases met the inclusion criteria. There were 5,356 OHCA cases (13.34%) with initial shockable rhythm and 33,974 (84.6%) with initial non-shockable rhythm. OHCA with initial shockable rhythm (Odds ratio/OR 6.10, 95% confidence interval/CI 5.06–7.34) and subsequent conversion to shockable rhythm (OR 2.00, 95% CI 1.10–3.65) independently predicted survival-to-hospital-discharge. After adjustment of baseline and prehospital characteristics, subsequent conversion to shockable rhythm significantly improved survival-to-admission (OR 1.53, 95% CI 1.13–2.08), discharge (OR 2, 95% CI 1.1–3.65) and post-arrest overall (OR 5.12, 95% CI 3.5–7.48) and cerebral performance outcomes (OR 5.39, 95% CI 4.32–6.73). In the 2-stage analysis, subsequent conversion to shockable rhythm significantly influenced survival-to-admission (OR 1.27, 95% CI 1.07–1.51) and discharge (OR 1.42, 95% CI 1.03–1.95) and good overall (OR 2.14, (1.92–2.38) and cerebral performance outcomes. (OR 2.2, 95% CI 1.97–2.46). **Conclusion:** Initial shockable rhythm was the strongest predictor for survival. However, conversion to subsequent shockable rhythm significantly influenced post-arrest survival and neurological outcomes. These results suggest the importance of resuscitation efforts even for initially non-shockable rhythms.

14. SLEEP-WAKE AND SHIFTWORK PATTERNS IN EMS CLINICIANS

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Background: Greater than half of Emergency Medical Services (EMS) clinicians report poor sleep and fatigue, placing them at risk of poor safety outcomes. The interaction between EMS clinician sleep-wake patterns, shift work, and fatigue is poorly understood. **Objective:** We sought to characterize patterns of sleep-wake and shift patterns of EMS clinicians working diverse shift schedules. **Methods:** We randomly selected 20 EMS clinicians participating in a randomized pilot trial (clinicaltrials.gov identifier NCT02063737). Ten from the intervention group and 10 from the control group completed a paper-based sleep diary for the last 14-days of the 90-day trial. Participants recorded time to bed, time sleeping, time out of bed, and sleep quality. We used descriptive statistics to characterize sleep patterns in relation to shift work and self-reported fatigue during shifts. We modeled the effect of shift length (h) on sleep duration, sleep quality, and fatigue using hierarchical linear models. **Results:** Seventeen participants provided complete sleep diaries, and 14 recorded at least one shift during the 14-day observation period. Mean number of shifts per participant was 5.4 (SD 2.5) and mean shift length was 17.8-hrs (SD 8.7). Ten of 14 participants (71%) worked shifts lasting 24-hrs or longer. Mean time off between scheduled shifts was 33.9-hrs (SD 28.4). Shift length for 8 participants (57.1%) did not vary, whereas 6 participants (42.9%) worked shifts ranging from 5-hrs to 48-hrs. Shift length did not predict sleep duration before ($p = 0.24$) or after a shift ($p = 0.42$). Shift length was not associated with sleep quality before ($p = 0.45$) or after ($p = 0.31$) shifts. Participants who only worked 8-hr shifts over 14-days achieved >7 -hrs of sleep ("Sufficient Sleep") before shifts 63% of the time, while participants that worked other shift durations and patterns obtained sufficient pre-shift sleep less

than half of the time (49%). Extended shifts (e.g., 24-h) and night shifts were not associated with self-reported fatigue at the start or end of shift ($p > 0.05$). **Conclusions:** In this sample, shift length alone was not associated with sleep duration, sleep quality, or self-reported fatigue at start or end of shift work.

15. AWARENESS AND SELF-EFFICACY OF CARDIOPULMONARY RESUSCITATION IN COMMUNITIES AND OUTCOMES OF OUT-OF-HOSPITAL CARDIAC ARREST: A MULTI-LEVEL ANALYSIS

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Background: This study aims to test the association between capacity of cardiopulmonary resuscitation (CPR) at community level and survival after out-of-hospital cardiac arrest (OHCA). **Methods:** Emergency medical service (EMS)-treated OHCA cases with cardiac etiology in Korea between 2012 and 2013 were analyzed, excluding cases witnessed by EMS providers. Exposure variables were five indices of community CPR capacity: awareness of CPR (CPR-Awareness), any training experience of CPR (CPR-Any-Training), recent CPR training within the last 2 years (CPR-Recent-Training), CPR training with a manikin (CPR-Manikin-Training), and CPR self-efficacy (CPR-Self-Efficacy). All measures of capacity were calculated as aggregated values for each county level using the national Korean Community Health Survey database of 228,921 responders sampled representatively from 253 counties in 2012. Endpoints were bystander CPR (BCPR) and survival to discharge. We calculated adjusted odds ratios (AORs) per 10% increment in community CPR capacity using multi-level logistic regression models, adjusting for potential confounders at individual levels. **Results:** Of 29,052 eligible OHCA cases, 11,079 (38.1%) received BCPR. Patients were more likely to receive BCPR in communities with higher proportions of residents with CPR-Awareness, CPR-Any-Training, CPR-Recent-Training, CPR-Manikin-Training, and CPR-Self-Efficacy (all $p < 0.01$). AORs for BCPR were 1.06 (1.03–1.10) per 10% increment in CPR-Awareness, 1.10 (1.04–1.15) for CPR-Any-Training, and 1.08 (1.03–1.13) for CPR-Self-Efficacy. For survival to discharge, AORs (95% CIs) were 1.34 (1.23–1.47) per 10% increment in CPR-Awareness, 1.36 (1.20–1.54) for CPR-Any-Training, and 1.29 (1.15–1.45) for CPR-Self-Efficacy. **Conclusion:** Higher CPR capacity at community level was associated with higher bystander CPR and survival to discharge rates after OHCA.

16. ASSOCIATION BETWEEN SURVIVAL AND INCREASES IN PREHOSPITAL SYSTOLIC BLOOD PRESSURE AFTER ITS NADIR IN MAJOR TRAUMATIC BRAIN INJURY: NEW FINDINGS FROM THE EPIC STUDY

Daniel W. Spaite, Chengcheng Hu, Bentley J. Bobrow, Duane Sherrill, Vatsal Chikani, Bruce Barnhart, Joshua B. Gaither, Kurt R. Denninghoff, P. David Adelson, Chad Viscusi, Terry Mullins, Uwe Stolz, University of Arizona

Background: A minimal amount is known regarding prehospital blood pressure patterns in Traumatic Brain Injury-TBI. In fact, the effect of serial trends in BP during EMS care remains entirely unknown. Using comprehensive, linked data in the Excellence in Prehospital Injury Care (EPIC) TBI Study (NIH: 1R01NS071049; ClinicalTrials.gov-NCT01339702), we evaluated the association between mortality and the magnitude of increase in EMS systolic BP (SBP) after the lowest SBP in major TBI. **Methods:**

All moderate/severe TBI cases (CDC-Barell Matrix Type-1) in the EPIC pre-implementation cohort (before TBI guideline implementation; 1/07–3/14) were evaluated to assess, in detail, a previous preliminary evaluation [exclusions: age10+, died before ED arrival, SBP = 0–39 mmHg or 300+ mmHg, missing SBP (4%)]. Logistic regression was used to determine associations between increases in EMS SBP after the lowest EMS SBP and the probability of death, adjusted for important confounders. **Results:** Among 14,567 included cases, 7636 (male = 68%, median age = 45) were in the cohort of interest (had an equal or higher SBP recorded subsequent to the lowest SBP). The study group was separated into four cohorts based upon each patient's lowest pre-hospital SBP (40–89 mmHg; 90–139; 140–159; 160–300). In each cohort, regression identified the association between mortality and any increase after the SBP nadir. Analysis of the probability of death vs. SBP increase after the nadir reveals distinct patterns: Hypotensive cohort-Mortality drops significantly if SBP increases after the nadir; the improvement is dramatic with large increases (SBP increases of 40–80 mmHg). Normotension-Mortality is slightly reduced with SBP increases and even large increases (i.e., 70–90 mmHg) were not detrimental. Mild Hypertension-Mortality decreases with modest SBP increases but large increases (>40 mmHg) are associated with higher mortality. Severe Hypertension-Higher Mortality occurs with any subsequent increase. **Conclusions:** The hypotensive and normotensive cohort findings support the concept that restoring/optimizing cerebral perfusion is important in the management of TBI as recommended in the NAEMSP/Brain Trauma FoundationEMS Guidelines. This conclusion is further supported by the fact that, even among cases with mild hypertension, moderate SBP increases do not appear to be detrimental. These results are also consistent with previous EPIC findings revealing that the optimal SBP in TBI may be much higher than previously thought.

Lightning Orals

17. DOES A NOVEL FEEDBACK MECHANISM IMPROVE QUALITY OF OUT-OF-HOSPITAL CPR?

Benjamin W. Weston, Jamie Jasti, E. Brooke Lerner, Aniko Szabo, Tom Aufderheide, Riccardo Colella, Medical College of Wisconsin

Background: Despite its prevalence, survival from out-of-hospital cardiac arrest remains low. Early defibrillation, greater compression fraction, optimal compression rate, sufficient compression depth, and shorter pre-shock pause have been associated with improved survival in cardiac arrest patients. In early 2014, a program was initiated to provide feedback on CPR quality to prehospital providers after every treated cardiac arrest. **Objective:** To assess whether individualized CPR feedback increased the number of patient encounters that met CPR quality metric goals or improved metric averages in the prehospital setting. **Methods:** This before and after retrospective review included all treated adult out-of-hospital cardiac arrest in patients in an urban community. Data was compared for the same two-month period prior to and after the initiation of the CPR feedback program. We compared the percent of patient encounters reaching the system defined benchmarks as well as the average values for compression fraction, compression rate, compression depth, and pre-shock pause in the before period compared to the after period. **Results:**

There were 159 prehospital encounters in the before period and 117 in the after period. As compared to the before group, the after group had shorter pre-shock pause times (21.4 sec vs. 14.7 sec; $p = 0.068$), higher average compression rates (111.2/min vs. 113.8/min; $p = 0.042$), increased compression depths (4.9 cm vs. 5.6 cm; $p < 0.001$), and increased rates of benchmark achievement for compression depth greater than 5cm (48.1% vs. 72.6%; $p < 0.001$). No difference was noted between groups for compression fraction, although goal achievement was high in both groups. **Conclusion:** We found that individual CPR feedback improved the quality of CPR in the prehospital setting. Further investigation with larger samples is warranted to better quantify this effect.

18. TEMPORAL TRENDS IN OUT-OF-HOSPITAL CARDIAC ARREST IN SOUTHERN ONTARIO

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Background: Considerable effort has gone into improving outcomes from out-of-hospital cardiac arrest (OHCA), with studies showing increasing survival over time. These increases can be attributed to evidence based guidelines, higher rates of bystander CPR and improved prehospital CPR quality, despite a decline in the incidence of ventricular fibrillation (VF) and pulseless ventricular tachycardia (VT). In prior studies, measures of effective implementation of evidence based guidelines are missing. **Objectives:** To evaluate temporal trends for OHCA survival using the Toronto Regional RescuNET cardiac arrest database over an 8-year period with active implementation of 2005 and 2010 Guidelines. **Methods:** This was an observational cohort study of all treated OHCA patients of presumed cardiac etiology between 2006 and 2014. We excluded OHCA patients with obvious etiology, paramedic witnessed and pediatric (<18 years) arrests. Temporal changes were measured by chi-square trend analysis. Logistic regression was used to test associations between year of OHCA and survival to hospital discharge with adjustment for Utstein variables. Analysis is ongoing to evaluate against optimal CPR measures and adherence to post arrest care guidelines. **Results:** A total of 25,568 patients were treated by paramedics and met inclusion criteria. During the study period, survival nearly doubled (3.7% in 2006 to 7.0% in 2014; $p < 0.001$) (Figure). Similar survival improvements were found in patients with VF/VT (12.2% to 21.8%; $p < 0.001$) and PEA (2.1% to 4.5%; $p = 0.001$) but not asystole ($p = 0.78$) as initial rhythms. When compared to 2006, survival was significantly better from 2010 onward [adjusted OR: 2010: 1.51 (1.09–2.09); 2011: 1.71 (1.25–2.35); 2012: 1.84 (1.34–2.52); 2013: 2.28 (1.68–3.10); 2014: 1.82 (1.34–2.48)]. Analysis is ongoing to evaluate against optimal CPR measures and adherence to post arrest care guidelines. **Conclusion:** Survival after OHCA has improved over time with significant increases coinciding with the knowledge dissemination of the 2010 resuscitation guidelines. Additional work is required to evaluate which measures are independently associated with survival that could drive guideline implementation efforts.

19. ELEVATED INITIAL TRAUMA CENTER BODY TEMPERATURES ARE ASSOCIATED WITH POOR NON-MORTALITY OUTCOMES FOLLOWING MAJOR TRAUMATIC BRAIN INJURY

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Background: In the prehospital setting hypotension, hypoxia, and hyperventilation are known to increase morbidity and mortality following Traumatic Brain Injury (TBI) by causing secondary brain injury. Previous reports have identified an association between elevated body temperature in the Intensive Care Unit (ICU) and increased mortality following TBI and there are multiple pathways through which elevated temperatures might cause secondary brain damage. However, minimal information is known regarding the relationship between an elevated initial trauma center body temperature (ITCT) and non-mortality outcomes. The purpose of this study was to determine if a correlation exists between elevated ITCT and important non-mortality patient outcomes. **Methods:** All moderate/severe TBI cases (CDC Barell Matrix Type 1) in the Arizona State Trauma Registry (ASTR); from 1/1/07–12/31/12 were analyzed and those with an elevated ITCT were placed into the following ITCT categories: 36.5–37.9°C (Normal Temperature - NT), 38.0–38.9°C (Elevated Temperature - ET), and $\geq 39.0^\circ\text{C}$ (Very Elevated Temperature - VET). Outcomes included: Trauma Center Length-Of-Stay (TC-LOS), Intensive Care Unit Length-Of-Stay (ICU-LOS), and Total Hospital Charges (THC) in US\$. A median regression model was applied adjusting for: ISS, age, gender, and trauma type (blunt vs penetrating). Cases with low ITCT were included in the median regression analysis but reported elsewhere. **Results:** A total of 22,925 cases met inclusion criteria. Case were excluded if missing ITCT (2,885) or missing demographics (700). The adjusted changes in median TC-LOS, ICU-LOS, and THC as compared to the NT group with 95% confidence intervals (CI) for the ET/VET groups respectively were as follows. The adjusted median TC-LOS increased by 0.4d (CI: 0.3–0.5)/1.10d (CI: 0.81–1.39). The adjusted median ICU-LOS increased by 0.23d (CI: 0.18–0.28)/0.38 (CI: 0.24–0.53). The adjusted median THC increased by \$4,582(3,582–5,623)/\$22,953(19,931–25,975). **Conclusion:** In this statewide study, patients with above normal body temperatures on arrival to the trauma had longer ICU-LOS, longer TC-LOS and increased hospital charges after adjusting for injury severity and other known cofounders. Future work is needed to identify the causes of temperature elevations that occur during prehospital TBI care (e.g., environmental factors vs. autonomic dysregulation) and whether initiation of in-field measures to prevent temperature elevation might improve outcome.

20. MAINTAINING HIGH QUALITY CPR WITH AN INTEGRATED MANUAL/MECHANICAL RESUSCITATION PROTOCOL

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Background: High quality manual chest compressions (CC) can be achieved on scene during resuscitation of cardiac arrest patients, but manual CC quality can deteriorate during patient extrication and transport. The purpose of this study was to describe the effect on CC quality of an integrated manual/mechanical chest compression protocol developed to maintain CC quality and patient/provider safety throughout resuscitation. **Methods:** CC quality was monitored using a monitor with

accelerometer-based CC sensing (E Series/X Series, ZOLL Medical) during the treatment of consecutive out-of-hospital cardiac arrest patients between 3/1/2013–4/30/2015. The EMS agency performed manual CC guided by real-time audiovisual feedback on scene but deployed the AutoPulse load-distributing band CC device (LDB, ZOLL Medical) in a choreographed manner for extrication and transport. The LDB was also placed prophylactically on patients after ROSC. Descriptive statistics are reported as median (IQR). **Results:** A total of 71 OHCA patients were treated (median age 58 yrs, 66% male) of which 39 received only manual CC and 32 received both manual and LDB CCs (22 with LDB deployed during ongoing manual CC and 10 with LDB placed after ROSC). With real-time CC feedback, high quality CCs were performed [depth 2.38 in (2.17–2.64), rate 100.3 cpm (99.2–102.5), CC fraction 87.0% (83.8–89.5)]. For patients requiring transport, the LDB was started after 14.2 min (11.6–19.2) of manual CC and was placed with minimal interruptions—total of 27.5 sec (23–42) pause time in 2 min prior to LDB deployment. During transport, CC fraction remained high (91.7%; 89.3–95.4) with use of LDB. Seven of 10 patients prophylactically placed on the LDB rearrested, 3 rearrested during transport. **Conclusion:** A choreographed and rehearsed integrated chest compression protocol featuring both manual and mechanical compressions, allows for high quality resuscitation with minimal compression interruptions. Placement of a mechanical device on patients after ROSC may be beneficial as over two-thirds of patients in this study rearrested, one-third of which occurred during transport when delivery of manual compressions is difficult and potentially dangerous.

21. A LONGITUDINAL ASSESSMENT OF STRESS AMONG EMS PROFESSIONALS

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Background: While national estimates of the prevalence of stress among EMS professionals are available, scant literature exists regarding incidence and longitudinal predictors of stress on a national level. **Objective:** 1) Estimate the incidence of stress among nationally certified EMS professionals 2) Describe factors associated with stress in this population. **Methods:** Data were obtained from the second Longitudinal EMTs Attributes and Demographics Study (LEADS II). Newly nationally certified EMTs and paramedics were recruited in 2013 to participate in an annual longitudinal questionnaire. These questionnaires contained previously validated work-life characteristics, demographics and items from the stress component of the Depression, Anxiety and Stress Scale (DASS-21). The validated seven-item DASS stress score characterizes an individual's level of stress as normal, mild, moderate, severe or extremely severe. Descriptive statistics were calculated and longitudinal mixed models were utilized to assess for associations between certification level, number of organizations worked for, service type, age, experience, leaving the profession and stress ($\alpha = 0.05$). **Results:** In 2013, 2,615 EMTs and paramedics were recruited into the study and 98.6% responded to the longitudinal questionnaire in 2013, 48.5% in 2014 and 41.0% in 2015. A stepwise increase in the prevalence of stress was observed (12.5% in 2013, 17.4% in 2014, and 22.2% in 2015). Of EMS professionals with normal stress levels in 2013, there were 89 new cases of stress (above normal levels) representing 15.7% of the study population or an incidence rate of 157 cases per 1,000 providers over the two year period. Certification level was the only factor assessed that

was significantly associated with stress; EMTs had a 10.1% increase in new stress cases over two years while paramedics had an increase of 22.5% (p -value = 0.0073). **Conclusions:** The prevalence of stress was substantially higher than previous 2009 estimates of the nationally certified EMS professionals. Further, there was a step-wise increase in the prevalence of stress among EMTs and paramedics from 2013 to 2015; more paramedics developed stress than EMTs. Although this study assessed changes in stress over two years, the long-term effects are largely unknown and identification of predictors should be of importance in future research efforts.

22. EFFECT OF EVENT LOCATION ON OUTCOMES OF DROWNING-ASSOCIATED OUT-OF-HOSPITAL CARDIAC ARREST: A NATIONWIDE OBSERVATIONAL STUDY

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Background: Drowning is one of the unintentional mechanisms for out-of-hospital cardiac arrest (Drowning-OHCA). The mandatory regulation for water safety is the core program to improve the rescue outcomes for Drowning-OHCA. We aimed to investigate the effect of the event location on outcomes of Drowning-OHCA. **Methods:** All EMS-treated Drowning-OHCAs from January 2006 to December 2013 were analyzed, excluding cases with primary cause, without information on location, and by suicide. Main exposure was event location such as recreational water group with mandatory safety regulation (swimming pool or beach), non-recreational water group without mandatory safety regulation (home or public bath), natural freshwater group (river or lake), and natural seawater (ocean). The main outcome was survival to hospital discharge. Confounders were adjusted for when calculating odds ratio (OR) and 95% confidence interval (CI) using multivariable logistic regression analysis (reference = recreational water). **Results:** In total 1,923 Drowning-OHCAs were finally analyzed (recreational water = 7.5%, non-recreational water = 12.1%, natural freshwater = 50.7%, and natural seawater = 29.7%). Survival-to-discharge rates were 4.6% for all cases, 12.4% in recreational water, 4.3% in non-recreational water, 3.3% for natural freshwater, and 4.9% in natural seawater, respectively ($p < 0.01$). Adjusted ORs (95% CIs) for survival compared with recreational water were 0.39 (95% CI 0.16–0.92) for non-recreational water, 0.29 (95% CI 0.16–0.55) for natural freshwater, and 0.48 (95% CI 0.24–0.94) for natural seawater, respectively. **Conclusion:** Drowning-OHCA occurring in recreational locations with water safety regulation showed much higher survival to discharge rate. Public awareness of the much higher risk of water locations without any safety regulation in Drowning-OHCA should be increased.

23. EXAMINING THE ACCURACY AND CONSISTENCY OF INTRAVENOUS MEDICATION INFUSIONS ADMINISTERED BY EMS PROVIDERS

Devin Turner, Elliot Carhart, Roanoke Fire-EMS Department

Background: Previous studies have shown deficiencies in the medication calculation skills of paramedics, but it remains unknown if they accurately administer such medications even when they correctly calculate the intended dose. The purpose of this study was to examine the accuracy and consistency of EMS providers when administering a simulated intravenous

(IV) medication infusion with a known drip rate using a conventional gravity-fed drip set. **Methods:** This IRB approved observational study included a convenience sample of 90 currently practicing advanced life support EMS providers (EMT-I and EMT-P) who were randomly assigned to one of three groups. In a classroom setting, the participants were provided a scenario requiring them to administer a simulated IV medication infusion for a period of 15-min using a conventional gravity-fed drip (60 gtt) set. Each scenario provided a different medication name and dose (Dopamine, Lidocaine, or Levophed), but all 3 were synchronized to the same fluid volume. Participants were provided with a pre-calculated drip rate. The fluid was administered into a graduated cylinder hidden from view of the participants. Measures of volume administered were recorded every three minutes in order to determine the accuracy and consistency of medication administration. **Results:** Participants ($N = 90$) infused the fluid at a consistent rate (ICC = 0.96), but 99% of participants administered an incorrect volume at one or more points of measurement. One-sample t tests showed that the mean volume of fluid administered differed significantly from the target volume at each point of measurement, thus rendering it inaccurate. The mean difference between the target volume and the volume administered was 2.54 mL at 3-min (95% CI = 1.68–3.41), which represented a 2.7-fold overdose. The 15-min mean difference of 2.09 mL (95% CI = 1.23–2.96) represented a 1.3-fold overdose. There were no differences in accuracy associated with gender, years of experience, certification level, individual agency, or between urban and rural providers. **Conclusion:** Participants in this study did not accurately administer simulated intravenous infusions according to predetermined drip rates. This leads to a concern of medication errors when infusing medications using a gravity-fed drip set. Additional safeguards should be implemented to ensure patient safety.

24. INCIDENCE OF ERRANT SHOCK DELIVERY IN OUT-OF-HOSPITAL CARDIAC ARREST RESUSCITATION

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Background: Defibrillation is used to convert ventricular fibrillation and tachycardia (VF/VT) to a perfusing sinus rhythm. However, rhythm analysis is subjective and shocks may be delivered errantly on rhythms that do not warrant nor positively respond to defibrillation. We sought to assess the rate and factors associated with errant shock delivery. We hypothesized that cases lacking VF/VT would receive a shock in the prehospital environment, and that errant shock delivery would occur more often in younger and female patients, as well as cases that were witnessed and those that occurred in public locations. **Methods:** We obtained IRB approval before commencing this study. Eligible cases of EMS-treated, non-traumatic OHCA spanned 2010–2014 at the Pittsburgh site of the Resuscitation Outcomes Consortium and contained at least one EMS-delivered shock. We excluded cases that did not receive any shocks. We analyzed all instances of EMS-delivered shocks in custom Matlab software. Pre- and post-shock rhythms were assessed for all shocks. Return of an organized rhythm (ROOR) was noted for every shock. Patient characteristics were obtained via patient care report review. We utilized t -tests with an alpha value of 0.05. **Results:** A total of 461 cases received at least one shock and contained a to-

tal of 1,377 analyzable shocks. Of these shocks, 1246 (90.5%) had VF/VT, and 131 (9.5%) had non-VF/VT. Errant shocks were delivered in a total of 91 (19.9%) cases. Errant shocks were most often the second shock delivered in the case. Demographic data was available for 457 (99.1%) of cases. ROOR occurred in 769 (55.8%) shocks. Errant shock delivery was not significantly associated with patient age ($p = 0.79$), sex ($p = 0.14$), location ($p = 0.83$), or witnessed status ($p = 0.63$). **Conclusions:** Errant shock rate was 9.5% and occurred in 19.9% of all cases. These shocks were not associated with common demographic data. Further work will examine other possible causes for errant shock delivery.

25. PUBLIC CARDIAC ARREST CHARACTERISTICS IN ENCLOSED PEDESTRIAN NETWORKS

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Background: Many metropolitan cities worldwide have underground or above-ground enclosed networks for pedestrian travel. These networks represent unique environments for studying out-of-hospital cardiac arrest (OHCA) and resuscitation since they are often located in population-dense regions, have high foot traffic, and connect to ground level open areas only at limited fixed points. The characteristics of OHCA that occur in such networks have not been studied before. **Objective:** To determine whether cardiac arrests that occur in enclosed pedestrian networks are different from those in the encompassing metropolitan city, using the PATH network in Toronto, Canada as a model site. **Methods:** Toronto is the fourth most populous city in North America (pop. 2.8 million). PATH is the largest underground shopping complex in the world that connects more than 50 buildings downtown, with over 200,000 commuters on business days. We identified all atraumatic, public-location OHCA in Toronto from Apr. 2006–Mar. 2015, and classified them according to location: Toronto, downtown, and PATH-accessible. PATH-accessible OHCA are those that occur within the Toronto PATH network between the first underground floor and the second above-ground floor. We collected demographic, prehospital intervention, and survival data for each OHCA. Statistical analysis was performed using a chi-square test. **Results:** We identified 2621 atraumatic public OHCA, of which 521 occurred in downtown and 50 occurred in PATH-accessible areas. In comparison to Toronto, PATH-accessible OHCA had significantly higher proportions of bystander witnessed OHCA (80% vs. 47%), bystander CPR attempt (70% vs. 42%), bystander AED use (38% vs. 8.5%), initial shockable rhythm (66% vs. 35%), overall survival (31% vs. 15%), with all differences being statistically significant ($p < 0.01$). When compared to downtown, PATH-accessible OHCA exhibited significant differences in all the aforementioned metrics. There were no significant differences in demographics, EMS response time, and survival among patients with shockable rhythm. **Conclusion:** The characteristics of OHCA in enclosed pedestrian networks differ significantly from those of its encompassing city. The similar rates of survival among patients with initial shockable rhythm despite higher rates of bystander resuscitation efforts, and OHCA with initial shockable rhythms make such networks potential regions of focus to further increase survival rates.

26. PARAMEDIC AND PATIENT POSITIONING AS A DETERMINATE FOR ENDOTRACHEAL INTUBATION

SUCCESS IN A SIMULATED AIRWAY MANAGEMENT SCENARIO

Mark E. Pinchalk, Francis X. Guyette, Lambert Patrick, David Miller, James Dlutowski, Stacey Gerstel, Emma Roka, Jeffery M. Reim Jr., Denisse Sequeira, City of Pittsburgh EMS

Background: Paramedics often must perform endotracheal intubation (ETI) in positions dictated by the physical location where the ETI attempt is made. The relative positioning of the patient and intubator may impact the ability to gain an adequate view of the glottis and the ability to successfully intubate the patient. The goal of this study was to determine what location and position of the patient and intubator would be associated with the greatest intubation success in a simulated case. **Methods:** A convenience sample of sixty (60) paramedics from a mix of urban and suburban EMS systems who volunteered and were provided informed consent participated in the study. Participants intubated a Sim-Man™ Advanced Life Support (ALS) manikin in six (6) scenarios: 1–2: Patient supine and head elevated on the stretcher in the ambulance, paramedic sitting in the “airway seat”; 3: Patient supine on the stretcher in a raised position outside the ambulance, paramedic standing; 4–6: Patient outside the ambulance supine on the floor, paramedic prone, sitting and kneeling. To simulate a difficult airway problem, the manikin was placed in spinal restriction with a longboard, cervical collar, and head immobilizer and an investigator held manual cervical spinal stabilization during the intubation attempt. **Results:** Compared to intubating in the ambulance with the stretcher supine, ETI with the patient supine on the floor and intubator prone had the highest probability of success (OR = 5.8, 95%CI: 1.21–27.7, $p = 0.03$). On a multivariate analysis the patient supine-paramedic prone position was also significantly better ($p = 0.01$, 95%CI: 0.04–0.23). All four (4) scenarios outside the ambulance were significantly or near significantly better for success than intubation in the ambulance: Stretcher outside the ambulance (OR = 2.8, 95%CI = 0.83–9.50, $p = 0.01$), patient supine – intubator kneeling (OR = 3.6, 95%CI: 0.94–13.83, $p = 0.06$) and patient supine–intubator sitting (OR = 3.8, 95%CI = 0.99–14.56, $p = 0.05$). **Conclusions:** In this simulation, performing ETI with the patient on the floor supine and the intubator prone had the highest probability of success. Performing ETI outside of the ambulance had superior success than performing it in the ambulance. This study may have operation implications as to where and when ETI is performed in the field.

Posters

27. STATEWIDE COMPARISON OF RSI SUCCESS RATES BETWEEN EMS AND SPECIALTY CARE TRANSPORT TEAMS

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Background: Specialty Care Transport (SCT) teams often have advanced airway training and a broader range of both experiences and equipment compared to EMT-Paramedic (EMT-P) 9-1-1 response teams. We hypothesized that rapid sequence intubation (RSI), using both a sedative and paralytic, would have higher success rates by SCT teams than EMT-P teams providing 9-1-1 responses. Endotracheal success rates are an important metric of patient safety in prehospital systems. **Methods:**

A statewide retrospective cohort analysis was done. Fourteen data elements were collected from the statewide EMS Airway Evaluation Form, which crews complete following all RSI attempts regardless of success or failure. Data include all patients aged ≥ 12 who underwent RSI between July 1, 2013 and December 31, 2015. There were no exclusion criteria and no cases with missing data. **Results:** During the study period 2,304 RSI procedures were performed statewide. EMT-P 9-1-1 response units performed 1,374 RSI procedures, and SCT teams performed 930 RSI procedures. Overall, EMT-P 9-1-1 response units failed to successfully place an endotracheal tube (ET) in 9.1% of cases ($n = 126$; 95% CI 7.7%–11%) and SCT teams in 2.9% ($n = 27$; 95% CI 2.0%–4.2%) of cases. The number of intubation attempts greater than 3 was low in both groups with EMT-P 9-1-1 response units in 1.2% (95% CI 0.8%–1.9%) of cases and SCT teams in 1.2% (95% CI 0.6%–0.2.1%) of cases. The rate of both failed intubation and failed placement of a secondary airway (no advanced airway) was also low in both groups with EMT-P 9-1-1 response units failing in 1.02% (95% CI 0.6%–1.7%) of cases and SCT teams in 0.43% (95% CI .1%–1.1%) of cases. **Conclusion:** We found a statistically significant overall increase in RSI success rates in SCT teams over EMT-P 9-1-1 response units by 6.2%. However, intubation attempts > 3 , and rate of failed placement of any advanced airway were found to be low in both groups, not statistically significant, and likely more relevant in terms of patient outcomes.

28. APNEIC OXYGENATION PREVENTS HYPOXEMIA DURING PREHOSPITAL ENDOTRACHEAL INTUBATION by CRITICAL CARE TRANSPORT PROVIDERS

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Background: Apneic oxygenation using high flow nasal cannula has been reported to significantly improve oxygenation during rapid sequence induction (RSI). However, there are no studies examining the effectiveness of this technique in the prehospital environment. This study sought to determine the effectiveness of apneic oxygenation for preventing hypoxemia during prehospital RSI. **Method:** We performed a retrospective observational study using a pre-existing database from a quality improvement project looking at intubation management by single critical care transport agency between July 2013 and June 2015. Apneic oxygenation using high flow nasal cannula (15 L/min) was introduced to the standard RSI protocol during this time. Prevention of hypoxemia was defined as maintaining oxygen saturation greater than or equal to 90% at all times. We compared patients who received apneic oxygenation during RSI to patients who did not using Fisher's exact test. Multiple logistic regression was also conducted to identify other factors protecting patient from hypoxemia during RSI. **Results:** Ninety-three patients were identified from the database, of whom 29 (31.2%) received apneic oxygenation. There was no statistically significant difference between the rate of hypoxemia between patients in the apneic oxygenation group vs. the control group (82.8% vs. 78.1%; $p = 0.78$). Using multiple logistic regression, apneic oxygenation was not significantly associated with protecting patients from hypoxemia (OR 1.33; 95% CI: 0.26–6.75). Factors that significantly decreased the likelihood of hypoxemia during intubation were successful intubation on the first attempt (OR 55.50; 95% CI: 6.53–471.85) and normal oxygen saturation prior to starting RSI (OR 56.26; 95% CI: 5.78–547.12). **Conclusion:** In this study, patients

who received apneic oxygenation did not show a statistically significant difference in hypoxemia during prehospital RSI. Successful intubation on the first attempt and normal oxygen saturation prior to starting RSI were associated with a lower likelihood of hypoxemia during the procedure.

29. ASSOCIATION OF AIRWAY MANAGEMENT WITH NEUROLOGIC OUTCOMES IN PATIENTS WITH OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Optimal airway management for out-of-hospital cardiac arrest (OHCA) remains unclear. Recent studies suggest that advanced airway interventions (AAI) do not improve neurologically-intact survival to hospital discharge. We compared OHCA outcomes between patients receiving AAI and those receiving basic airway interventions (BAI). **Methods:** We analyzed data from the San Antonio OHCA Database for calendar year 2014. We excluded all patients under 18 years old. Primary variables were AAI (endotracheal intubation [ETI] or supraglottic airway [SGA]) or BAI. The primary outcome was neurologically-intact survival (cerebral performance category [CPC] 1–2) to hospital discharge. **Results:** Of 1,150 adult OHCA cases, 926 had all relevant data recorded. The 519 received ETI, 340 SGA, and 67 BAI. Neurologically-intact survival was: ETI 4.6%, SGA 3.2%, BAI 11.9%. Chi square testing determined patients receiving BAI were more likely to have a neurologically-intact survival to hospital discharge ($p = 0.003$). **Conclusion:** Our unadjusted OHCA data suggests that AAI offer no benefit in regard to neurologically-intact survival to hospital discharge. Performing a propensity score matched analysis would improve the validity of these findings. However, prospective trials are needed to determine the best airway strategies in OHCA.

30. SKEPTIC - SAFETY AND EFFICACY OF KETAMINE IN EMERGENT PREHOSPITAL TRACHEAL INTUBATION: A CLINICAL REVIEW

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Background: Rapid Sequence Intubation (RSI) is a critical skill in the paramedic scope of practice. Advanced airway management, especially in the emergent patient, is associated with many variables outside the control of the practitioner. Ketamine has gained increasing popularity as a dissociative anesthetic in the emergency department. As an NMDA receptor antagonist, it has a favored hemodynamic profile, increasing the duration of catecholamine in the synapse. The peri-intubation patient is at high risk of relative hypotension due to the medications used in RSI, positive pressure ventilation, let alone the inherent intricacies of the patient's medical condition. Patients with shock physiology upon EMS arrival are at the highest risk of further hemodynamic decompensation. Ketamine, because of its sympathomimetic properties, may be a useful adjunct in the RSI process for prehospital patients requiring emergent tracheal intubation. **Objective:** This study aims to investigate ketamine as an induction agent in prehospital RSI as well as its association with change in vital sign parameters and shock index during the peri-intubation period. Subgroup analysis is performed to potentially identify patients that benefit preferentially from ketamine induction. **Methods:** SKEPTIC is a retrospective review of RSI in a two-tiered

EMS system with a mixed urban and suburban catchment. Patients who received emergent prehospital tracheal intubation during the study period (1/1/14–2/28/15) were selected by review of the electronic patient care record (e-PCR). **Results:** A total of 201 patients were included for analysis. Patients were categorically sorted by pre-RSI Systolic Blood Pressure (SBP) into hypotensive (SBP 140, $n = 123$) groups. The data had a non-normal distribution with parametric testing yielding median values used for statistical analysis. The hypotensive group was the area of primary focus: Median Shock Index (SI) pre-RSI was 1.047 (IQR: 0.21) and post-RSI SI was 0.968 (IQR: 0.252), $p = .001$. Subset analysis of patients displaying shock physiology (SBP < 90, $n = 15$) had median SI pre-RSI of 1.238 with a post-RSI SI of 0.960, $p = .023$. **Conclusion:** Ketamine for RSI induction can improve the hemodynamics of prehospital patients requiring a definitive airway during the peri-intubation period.

31. UNRECOGNIZED FAILED AIRWAY MANAGEMENT USING A BLIND-INSERTION SUPRAGLOTTIC DEVICE

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Background: Many 9-1-1 Emergency Medical Services (EMS) systems now incorporate blind-insertion supraglottic devices for either primary or rescue advanced airway management. Although unrecognized failed endotracheal tube placement has previously been evaluated, there is a paucity of literature concerning unrecognized supraglottic airway misplacement by prehospital providers. The objective of this study was to determine the prevalence of unrecognized misplaced supraglottic airways in a large urban 9-1-1 EMS system. **Methods:** A retrospective review of patients who underwent airway management using the King LTS-D supraglottic airway. The study period was March–July, 2015. Inclusion criteria: All successful King LTS-D attempts documented by EMS providers on the electronic patient care report (ePCR). Exclusion criteria: All King LTS-D placements documented as unsuccessful by prehospital providers. Data were analyzed and correlated for subjective success documented by providers, and for objective success defined by the presence of a 4-phase waveform capnography tracing greater than 5mmHg. **Results:** A total of 343 blind-insertion supraglottic airway attempts met inclusion criteria. A total of 37 attempted placements documented as unsuccessful were excluded from further analysis. Data were unavailable for 71 cases because of unavailable capnography data, leaving 235 cases for review ($n = 235$). The primary call type was Cardiac Arrest (218), followed by Trauma (11), Breathing Problem (4), and Unconscious (2). No patients met obvious death criteria. A total of 198 cases met the definition for objective success, representing an unrecognized failed airway rate of 15% (37/235). **Conclusion:** As is the case with endotracheal intubation, the use of blind-insertion supraglottic airway devices may result in unrecognized failed placement. Appropriate utilization and review of waveform capnography may remedy a potential blind-spot in patient safety and systemic monitoring/feedback processes and may therefore prevent unrecognized misplaced airways.

32. SPATIOTEMPORAL STABILITY OF PUBLIC CARDIAC ARRESTS

Derya Demirtas, Steven C. Brooks, Laurie J. Morrison, Timothy CY Chan, University of Toronto

Background: Public access automated external defibrillator (AED) deployment and community cardiopulmonary resuscitation (CPR) programs should target geographical areas with high risk of out-of-hospital cardiac arrest (OHCA). Although these long-term, location-based interventions implicitly assume that the geographical OHCA risk remains stable over time, there is a paucity of evidence to support this assumption. **Objective:** To determine whether geographic OHCA risk is stable over time in a Canadian urban setting. **Methods:** We identified all atraumatic public-location OHCA in Toronto, Canada from Jan. 2006–Dec. 2014 and allocated each of them to one of the 140 neighborhoods defined by the City of Toronto. We then calculated the intraclass correlation coefficient (ICC) to measure the relative variability of OHCA counts within and between neighborhoods over time. **Results:** We identified 2506 atraumatic public OHCA. The average number of public OHCA in Toronto was 278.4 (± 41.4) per year. The highest risk neighborhood had an average number of 12.9 OHCA per year and remained the highest risk neighborhood during six of the nine years. The four lowest risk neighborhoods each had a rate of 0.1 OHCA per year. The ICC value was 0.67 [95% CI, 0.61–0.73], indicating that there was less year-to-year variation within the same neighborhood (i.e., more temporal stability) and more variation between neighborhoods. **Conclusion:** The OHCA rate in Toronto is stable at the neighborhood level over time. High risk neighborhoods tend to remain high-risk, which supports focusing public health resources in those areas to increase the efficiency of these scarce resources and improve long-term impact.

33. ETCO2 ALONE IS INADEQUATE TO VERIFY CPR QUALITY

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Background: Previous studies have described modest correlation between end-tidal CO₂ (ETCO₂) and CPR quality during resuscitation of cardiac arrest patients, but it is unclear whether ETCO₂ alone can indicate CPR quality. The present study investigated whether ETCO₂ adequately identifies the quality of CPR provided during out-of-hospital cardiac resuscitation. **Methods:** ETCO₂ was monitored with side-stream CO₂ (Philips/Respironics) and CPR quality measured with an accelerometer-based system (E Series, ZOLL Medical) during the treatment of consecutive adult OHCA patients with presumed cardiac etiology by 2 EMS agencies in the Arizona SHARE QI Program between 10/08–06/13. Minute-by-minute ETCO₂ and CPR quality were extracted. ETCO₂ values were log transformation to achieve approximate normality. Linear mixed effect models were fitted to use (transformed) ETCO₂ level to predict four CPR variables: chest compression (CC) depth, CC rate, CC release velocity (CCRV), and ventilation rate (VR). A random intercept for each case was included and a spatial power covariance structure assumed for measurements over time. **Results:** 230 subjects (median age 69 yr, 69% male) with 1581 min of data were studied. Transformed ETCO₂ was significant for CC depth ($p < 0.0001$), CCRV ($p = 0.003$) and VR ($p < 0.0001$), but only explained 3.7%, 2.7%, and 10.0% of the total variance for these variables, respectively. Transformed ETCO₂ was not a significant predictor for CC rate ($p = 0.89$). **Conclusion:** In this secondary analysis, ETCO₂ was not an independent indicator of CC rate but was a weak predictor for CC depth, CCRV and VR. These find-

ings suggest that ETCO₂ may be not be an adequate substitute for CPR quality monitoring. Future studies should investigate how ETCO₂ and CPR quality monitoring can be used in conjunction to optimize CPR.

34. TRUE PUBLIC ACCESS DEFIBRILLATOR COVERAGE IS OVERESTIMATED

Christopher L. F. Sun, Derya Demirtaş, Steven C. Brooks, Laurie J. Morrison, Timothy CY Chan, University of Toronto

Background: Out-of-hospital cardiac arrests (OHCAs) occur at all times of the day and night. Immediate access to an AED increases survival. However, most public-location AEDs are placed in buildings without 24-hour access. **Objective:** To measure fixed-location public AED coverage of OHCAs by time of day and day of week in a Canadian urban setting. **Methods:** We identified all atraumatic public OHCAs occurring in Toronto, Canada from Jan. 2006–Aug. 2014. We obtained a list of registered AEDs from Toronto Emergency Medical Services as of March 2015 and determined the hours that each AED was available based on operating hours of the building housing the AED. We counted the number of OHCAs that occurred within 100 m of an AED (“assumed 24/7 coverage”) and the number that occurred both within 100 m of an AED and when the AED was available (“actual coverage”). Statistical analysis was performed using a χ^2 test. **Results:** We identified 2,440 atraumatic public OHCAs and 737 registered AED locations. A total of 451 OHCAs were covered under assumed 24/7 coverage. In terms of actual coverage, 354 OHCAs were covered, representing a coverage loss of 25.5%. Coverage decreased by 8.6% during the day (8am–3:59pm), 28.6% in the evening (4pm–11:59pm), and 48.4% at night (12am–7:59am); the differences were statistically significant ($p < 0.001$). During the evenings, nights, and weekends the coverage loss was 31.6%, which is when the majority (66.1%) of the OHCAs occurred. The largest coverage losses were found in schools (39.7%), industrial facilities (39.3%), recreation facilities (37.1%), and offices (35.7%). Transportation facilities, long term care homes and homeless shelters had no coverage loss. **Conclusion:** One out of every four OHCAs in proximity of an AED occurs when that AED is inaccessible due to lack of 24/7 access. When deciding on candidate locations for placement of AEDs, temporal access should be considered to maximize the number of lives saved.

35. MYOCARDIAL CONTRACTION DETECTION USING A CPR FEEDBACK SENSOR

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Background: The incidence of pulseless electrical activity (PEA) in out-of-hospital cardiac arrest appears to be increasing. Accurate diagnosis of PEA requires detecting absence of myocardial contractions, which is typically done using hemodynamic measurements, such as non-invasive blood pressure. At low pressures, distinguishing between PEA and perfusing rhythm can be challenging. Our objective was to evaluate whether an accelerometer already in place for CPR feedback could be used to detect myocardial contractions. **Methods:** Digitized ECG recordings and accelerometer signals were downloaded from ZOLL AEDs from multiple emergency medical services (EMS). Accelerometer signals were arbitrarily selected from pre-shock pauses where VF was the underlying rhythm. This set of data represented the non-perfusing rhythms and was compared to arbitrarily selected samples from organized rhythms identified in post-shock pauses dur-

ing rhythm check. All organized rhythms were confirmed to be perfusing rhythms by the presence of systolic blood pressure measurements (>100 mmHg). A low-pass filter with a cut-off frequency between 0.75 to 3 Hz was applied to the accelerometer signal to eliminate high-frequency noise. Cross-correlation function was then calculated between the ECG and the filtered accelerometer signals to obtain the peak correlation coefficient (CCp). A ROC curve was then constructed for the ability of the CCp to predict a perfusing rhythm. **Results:** 20 perfusing and 20 non-perfusing rhythm epochs from a total of 40 patients were included. The filtered accelerometer tracings in perfusing rhythms showed periodic oscillations synchronized with R waves in the ECG tracings. In the non-perfusing rhythm group, filtered accelerometer tracings did not show periodic oscillations. The peak amplitude of accelerometer tracings was 0.021 ± 0.008 (G) in perfusing rhythms, and 0.019 ± 0.014 (G) in non-perfusing rhythms. With CCp as the classification variable to predict perfusing rhythm, the area under the ROC curve was 0.87. Using a CCp of 0.128 as cut-off resulted in a value of 0.7 for sensitivity, specificity and positive predictive value for perfusing rhythm. **Conclusions:** An accelerometer used for CPR quality monitoring (CPR feedback) could also be used during compression pauses to distinguish between PEA and perfusing rhythm by applying a low pass filter and cross-correlating to the ECG.

36. RHYTHM CHANGES FOLLOWING DEFIBRILLATION DURING RESUSCITATION IN OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Current guidelines recommend immediate resumption of chest compressions after defibrillation. If a shock fails to establish return of spontaneous circulation, chest compressions may improve oxygen and substrate delivery to the myocardium, making subsequent shocks more likely to succeed. However, it is unclear what the optimal timing is to determine presence of an organized rhythm. The purpose of this study was to investigate rhythm changes occurring after defibrillation. **Methods:** A total 581 shocks from 264 out-of-hospital cardiac arrest patients with ventricular fibrillation (VF) as initial rhythm were included in this study. Post shock rhythms were analyzed every 10 seconds after each shock up to 120 seconds. We determined presence of VF, asystole (AS), and organized rhythm (OR) at each time point. **Results:** Ten seconds after shock delivery, VF had been terminated in 70.4% cases ($N = 409$). However, 53.5% of these non-VF rhythms were AS ($N = 219$). Rhythm changes occurred in half of all cases ($N = 274$, 47.2%) during the 2 minutes after shock delivery (Figure 1 and 2) and 88.3% of these changes occurred within 60 sec. Of those initially in AS, 62 (28.3%) evolved into OR within 32.4 ± 24.6 seconds and 117 (53.4%) returned to VF after 31.3 ± 19.9 seconds. Of those with OR ($N = 190$), 89 (46.8%) returned to VF 40.2 ± 28.2 seconds later and 6 degenerated to AS (3.2%) after 48.3 ± 41.7 seconds. VF recurred in 50.4% ($N = 206$) non-VF rhythms but there were no post-shock rhythm changes in patients remaining in VF ($N = 172$) after shock delivery. **Conclusion:** Post-shock rhythms are volatile in the first minute after shock delivery. Chest compressions should resume for at least 60 sec after a shock before rhythm and pulse are checked. Technology displaying cardiac rhythm during chest compressions could help to decide whether chest compressions should be stopped for a pulse check.

37. IMPROVED OUTCOMES OF EXTRACORPOREAL CARDIOPULMONARY RESUSCITATION FOR OUT-OF-HOSPITAL CARDIAC ARREST: A COMMUNITY-WIDE EVALUATION

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Background: The outcome of patients after out-of-hospital cardiac arrest (OHCA) is poor. Return to spontaneous circulation (ROSC) dramatically decreases with the duration of cardiopulmonary resuscitation (CPR). It has been proposed to implement venoarterial ECMO (extracorporeal membrane oxygenation) in order to assist CPR (ECPR) in OHCA. The study aim was to investigate the effects of ECPR for OHCA. **Methods:** A prospective four-year community-wide observational database collected from an OHCA web e-registry in a metropolitan EMS (emergency medical services) was studied. The EMS ambulance teams were capable with advanced airway, intravenous fluid skills, basic and advanced life support and AED (automated external defibrillator) techniques. Outcomes included 2-hour and 24-hour sustained ROSC, survival and cerebral performance category scale (CPC) at discharge. OHCAs receiving ECPR in emergency were included and their prehospital and hospital characteristics and outcome relations were evaluated by regression analysis. **Results:** In the last 4 years among a total of 7,220 OHCA resuscitated, ECPR was used 88 times (90% male, median age 54 [IQR 44–63]), 90% non-traumatic, 58.6% arrest witnessed, 50.6% receiving bystander CPR, up to 72.6% initial AED rhythm presenting shockable, LMA (laryngeal mask airway) applied on 54%, endotracheal intubation applied on 5.7%, prehospital intravenous epinephrine for 18.2%, and therapeutic hypothermia for 12.5% of cases. Prehospital time intervals (min:sec, median [IQR]) were 04:38 [03:30–06:08] for response, 13:00 [10:05–16:00] for scene, and 03:08 [02:09–05:00] for transport. Only 10.2% of cases presented prehospital ROSC and 9.1% got ROSC upon hospital arrival. Outcomes respectively were 88.6% for 2-hr ROSC, 69.3% for 24-hr ROSC, 39.1% for survival to discharge, and 21% for good neurological CPC1 or 2. Patients with CPC1 or 2 tended to be younger (median age 46.8 vs. 55.9, $p = 0.04$) and less with LMA (29.4 vs. 61.9%, $p = 0.02$). **Conclusions:** ECPR can lead to survival and good neurological outcome in selected OHCA regardless of positive ROSC at prehospital or upon hospital arrival after EMS resuscitation. Elder age and prehospital LMA may be adverse to neurological outcome for ECPR of OHCA.

38. COMPARISON OF PATIENT CHARACTERISTICS AND OUTCOMES BETWEEN ADULT NON-TRAUMATIC OUT-OF-HOSPITAL CARDIAC ARRESTS WITH AND WITHOUT EXTRACORPOREAL CARDIOPULMONARY RESUSCITATION: A COMMUNITY-WIDE EVALUATION

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Background: The outcome of patients after OHCA is poor. Return of spontaneous circulation (ROSC) dramatically decreases with the duration of CPR. Extracorporeal membrane oxygenation has been proposed to assist CPR (ECPR) in OHCA. This study was to investigate the effects and characteristics of ECPR for adult non-traumatic OHCA vs. Non-ECPR on a community-wide basis. **Methods:** A prospective four-year observational database collected

from a community-wide OHCA web registry in an urban EMS (emergency medical services) was studied. The EMS ambulance teams were capable with advanced airway, intravenous (IV) fluid skills, basic and advanced life support, and automated external defibrillator techniques. Outcomes included survival and cerebral performance category scale (CPC) at discharge. Adult non-traumatic OHCA with and without ECPR were compared by regression analysis including patient factors, prehospital and hospital characteristics, and outcomes. **Results:** Comparing OHCA receiving ECPR ($n = 79$) to those without ($n = 959$), ECPR group were younger (median age 56 vs. 78, $p < 0.001$) and had higher portion of men (89 vs. 64%, $p < 0.001$), witnessed arrest (Wit, 60.8 vs. 32.5%, $p < 0.001$), bystander CPR (BCPR, 53.2 vs. 36.8% $p = 0.005$), initial shockable rhythms (SR, 74.6 vs. 12.2%, $p < 0.001$) and therapeutic hypothermia (TH, 22.8 vs. 1.1%, $p < 0.001$). They (ECPR vs. non-ECPR) had no difference for prehospital time intervals (22.5 vs. 23 min.), laryngeal mask airway treatment (55.7 vs. 52.8%), EMS IV epinephrine (20.3 vs. 15.5%), endotracheal intubation (6.3 vs. 8.0%), prehospital ROSC (11.4 vs. 6%, $p = 0.09$), and ROSC upon hospital arrival (10.1 vs. 8.5%). Outcomes were better in ECPR for discharged survival (41 vs. 7%, $p < 0.001$) and CPC 1or2 (20.8 vs. 3.8%, $p < 0.001$). After adjusting for Wit, BCPR, SR, TH, age, and sex, both survival (adjusted odds ratio: 3.6 [95% 2.0–6.6]) and good CPC 1or2 (adjusted OR: 2.9 [95% 1.2–6.9]) were still significantly higher in ECPR. **Conclusions:** In current clinical practice for adult non-traumatic OHCA, ECPR tended to apply to patients of younger age, men, witnessed arrest, BCPR, and initially shockable rhythms regardless of positive ROSC upon hospital arrival, that can independently lead to higher survival and good neurological outcome compared to non-ECPR.

39. THE IMPACT OF FIRST RESPONDER TURNOUT TIME ON SURVIVAL FROM OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Patients with out-of-hospital cardiac arrest (OHCA) are more likely to survive when emergency medical services (EMS) arrive quickly. Turnout time is the interval between notification of an incident and when the assigned vehicle begins moving. A 60-sec turnout time standard has been proposed. We hypothesize that as turnout time increases, survival to hospital discharge from OHCA decreases. **Methods:** We retrospectively evaluated responses to adult non-traumatic OHCA on EMS arrival from 2009 to 2014 in an urban, fire department based system. Turnout time was calculated from the computerized time stamps for dispatch activation until first responding fire personnel pressed the "en route" button on the mobile data terminal. We categorized turnout time, in seconds, into two groups: 0–60 (short) and >60 (long). Cases in each category were compared with OHCA survival to hospital discharge. We used logistic regression modeling to ascertain whether turnout time independently predicted OHCA survival to discharge. **Results:** Of 2,485 treated OHCA responses, 739 (30%) were excluded for: OHCA after EMS arrival, age <18, DNR orders, no advanced life support (ALS) treatment, ALS treatment by outside agencies, special events, and missing data, leaving 1,741 for analysis. The median turnout time was 59 sec, and 50% were between 45 and 78 sec. Approximately 53% met the 60-sec standard, and 47% were longer.

Turnout accounted for 16% of the interval from 9-1-1 call receipt to fire personnel beginning chest compressions. Turnout was shorter when initial dispatch indicated OHCA (61 ± 28 vs. 65 ± 30 ; mean difference 4, 95% CI 1–7) and when OHCA occurred during the day vs. night (56 ± 27 vs. 78 ± 29 ; mean difference 22, 95% CI 19–25). No differences in survival to discharge, return of spontaneous circulation, or finding an initial shockable rhythm were appreciated between the two turnout time groups. Logistic regression was unable to demonstrate a statistical relationship between turnout time and OHCA survival ($p = 0.28$). **Conclusions:** Turnout time represents about a sixth of the overall response interval. A possible explanation for failure to detect an effect on long term survival is the relative consistency in turn out time intervals in this system.

40. UTILIZATION AND OUTCOMES WITH MECHANICAL CPR DEVICES: A POPULATION-BASED STUDY USING THE CARDIAC ARREST REGISTRY TO ENHANCE SURVIVAL (CARES)

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Background: High quality chest compressions during cardiopulmonary resuscitation (CPR) are considered to be one of the most important factors in determining outcomes of out-of-hospital cardiac arrests (OHCA). Multiple studies have highlighted the challenges in providing consistent high quality CPR, resulting in the promotion of the use of mechanical devices to perform chest compressions. However, there is conflicting evidence about the use of mechanical devices and their association with neurologically favorable outcomes. **Objective:** We aimed to characterize factors associated with the provision of mechanical CPR and test the hypothesis that use of mechanical CPR devices in patients with OHCA is associated with improved neurological outcomes as compared to patients who receive manual CPR. **Methods:** We conducted an analysis of the Cardiac Arrest Registry to Enhance Survival (CARES) database. Inclusion criteria included all non-traumatic OHCA from January 1, 2013 through December 31, 2014. **Results:** A total of 49,977 cardiac arrests were evaluated. Mechanical CPR use occurred in 10,378 (20.8%). The mean age of patients who received mechanical device compressions was 62.5 ± 17.2 years and almost 65% were male. Active compression-decompression devices were the most commonly used devices (16.5%). Most patient and arrest characteristics were similar among patients receiving conventional CPR and mechanical CPR, with the exception that impedance threshold devices were more commonly used with mechanical CPR devices (42.5% vs. 12.3%, $p = < 0.0001$). The majority of arrests receiving mechanical CPR occurred at home (83.8%), were unwitnessed (56.9%), and were presented in a non-shockable rhythm (77.7%). Overall, mechanical CPR was associated with worse outcome as compared to manual CPR (OR = 0.80, 95% CI 0.66–0.97). In sub-group analyses, mechanical CPR use was associated with worse neurological outcomes outside of the home (OR = 0.56, 95% CI = 0.38–0.80). **Conclusion:** Overall, mechanical CPR devices were utilized in 20% of out-of-hospital cardiac arrests. Active compression-decompression devices were the most commonly utilized type of device and were often used in tandem with an impedance threshold device. Overall, use of a mechanical CPR device was associated with worse outcomes. However, more study is needed to determine the impact of device vs. patient characteristics on observed outcome differences.

41. ASSOCIATION BETWEEN HIGHLY-EDUCATED NEIGHBORHOODS WITH PROVISION OF BYSTANDER CARDIOPULMONARY RESUSCITATION

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Background: We hypothesized that a higher proportion of highly-educated residents in a community is associated with a greater likelihood of provision of bystander cardiopulmonary resuscitation (BCPR) for out-of-hospital cardiac arrests (OHCAs). **Methods:** A population-based observational study was conducted with OHCAs of cardiac etiology in Korea who were witnessed by laypersons between 2012 and 2013. Exposure variable was the proportion of highly-educated residents (high school graduates and above) in a community categorized into quartile groups. End-points were provision of BCPR and early chest compression (within 4 min of collapse). Multivariable logistic regression analysis was performed. A final model with an interaction term was evaluated to test interactive effects of community education level with dispatcher-provided CPR instruction. **Results:** A total of 10,694 OHCAs were analyzed. BCPR was performed in 5,112 (47.8%), and early CPR was done in 3,080 (28.8%). Compared with the highest educated communities, AORs (95% CIs) for BCPR were 0.84 (0.74–0.95) in higher, 0.78 (0.66–0.92) in lower, and 0.71 (0.60–0.85) in the lowest educated communities. For early chest compression, AORs (95% CIs) were 0.90 (0.79–1.02) in higher, 0.81 (0.66–0.99) in lower, and 0.62 (0.50–0.76) in the lowest educated community. In an interaction model of 4,122 OHCA patients who received dispatcher-provided CPR instruction, OHCAs occurring in higher (AOR = 0.80 [0.67–0.96]), lower (AOR = 0.67 [0.52–0.87]), and the lowest (AOR = 0.59 [0.43–0.82]) educated communities were less likely to receive BCPR compared with the highest educated communities. **Conclusion:** OHCA occurring in communities with a higher proportion of highly-educated residents were more likely to receive BCPR and early chest compressions, and the disparity was more prominent in the group that received dispatcher-provided CPR instruction.

42. DISPARITIES IN UTILIZATION OF 9-1-1 FOR OUT-OF-HOSPITAL CARDIAC ARRESTS AMONG SPANISH SPEAKING CALLERS

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Background: One-third of Hispanics in the United States have limited English proficiency (LEP). In the Phoenix, Arizona metropolitan area, this equals approximately 441,429 residents. This subgroup faces barriers to accessing EMS and receiving life-saving pre-EMS arrival cardiopulmonary resuscitation (CPR) instructions. The use of 9-1-1 for out-of-hospital cardiac arrests (OHCAs) and CPR is a potentially modifiable factor to reduce disparities in outcomes. The purpose of this study was to describe the utilization of the 9-1-1 system during OHCA and to assess if CPR instructions were provided at the same rate compared with non-Spanish speaking callers. **Methods:** OHCA data from 9-1-1 centers linked with EMS and hospital outcomes from October 2010 through December 2013. Review of audio Telephone-CPR (TCPR) process data include: 1) the proportion of cases where dispatchers recognize the need for CPR; 2) the proportion of cases where dispatchers start CPR instructions; and 3) the barriers dispatchers and callers encounter to

getting CPR started. **Results:** A total of 5,555 calls were made to 9-1-1 for OHCA with CPR needs. The average age of callers was 61 (SD = 20). Of these calls, 3,643 died, 486 lived, and 1,426 had status unknown. When no language barrier was documented, CPR was indicated for 86% of callers and when a language barrier was documented, CPR was indicated for 94% of callers ($\chi^2 = 4.6$; $p = 0.03$). There was a strong association between language barrier and delay of CPR ($\chi^2 = 66.5$; $p < 0.001$). A total of 97 calls (1.7%) indicated a language barrier, of which 56 (1.0%) indicated that the language was Spanish. This averages to 18 calls per year with a Spanish-language barrier during the study period. The OHCA incidence among Hispanics of 65 per 100,000 per year translates to 286 OHCA's expected per year among the Hispanic LEP population in the Phoenix metropolitan area. Eighteen observed 9-1-1 calls compared to 286 expected OHCA's per year documents a large disparity in this growing population. **Conclusions:** Hispanic LEP patients in the Phoenix metropolitan area utilize 9-1-1 for OHCA at a significantly lower rate than their population size would predict. Further research is needed to address the possible causes of this disparity.

43. INTERACTIVE EFFECTS BETWEEN DIABETES MELLITUS AND AGE ON RISK OF OUT-OF-HOSPITAL CARDIAC ARRESTS

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Background: This study aimed to evaluate the risk of diabetes mellitus (DM) on incidence of out-of-hospital cardiac arrest (OHCA) and to investigate whether an interactive effect between DM and patient age was observed. **Methods:** This study was a case-control study using the Cardiac Arrest Pursuit Trial with Unique Registration and Epidemiologic Surveillance (CAPTURES) project database and 2013 Korean Community Health Survey (CHS) in Korea. Cases were defined as EMS-treated OHCA patients with presumed cardiac etiology from January to December 2014 who were older than 18 years. OHCA which occurred at nursing home or clinics and cases with unknown information on DM were excluded. Four controls were matched per one case with strata including age, gender, and county from the Korean CHS database. A multivariable conditional logistic regression analysis was conducted to estimate the risk of DM on OHCA and interaction model was conducted. **Results:** We enrolled 1,386 OHCA patients and 5,544 community-based controls. Of cases, 370 (26.7%) were diagnosed DM, whereas 860 (15.5%) were diagnosed among community controls. DM was associated with increasing risk of OHCA (AOR (95% CI): 1.92 (1.65-2.24)). In the interaction model, the effect size of DM was decreased according to increased age: AOR (95% CI) was 5.05 (2.74-9.30) in 19-49 years old group; 3.55 (2.48-5.08) in 50-59 years old group; 1.95 (1.40-2.73) in 60-69 years old group; and 1.46 (1.19-1.78) in older than 70 years group. **Conclusions:** The risk of cardiac arrest in DM was the highest for the younger people, and the magnitude of risk decreased by increasing age. These results emphasize the hazard of DM as an independent risk factor for cardiac arrest, and importance of intensive risk management considering patients' age.

44. EFFECTS OF INTER-HOSPITAL TRANSFER ON POST-RESUSCITATION OUTCOMES IN PATIENTS WITH OUT-OF-HOSPITAL CARDIAC ARREST

Ki Ok Ahn, Sang Do Shin, Joo Young Kim, Yu Jin Lee, Eui Joong Lee, Young Sun Ro, Seoul National University Hospital

Background: This study aimed to determine the risk of inter-hospital transfer on post-resuscitation outcomes of out-of-hospital cardiac arrest (OHCA). **Methods:** This study was an observational study using the Cardiac Arrest Pursuit Trial with Unique Registration and Epidemiologic Surveillance (CAPTURES) project database. EMS-treated adult patients (over the age of 18) with OHCA of presumed cardiac etiology were registered at 29 hospitals from January to December 2014. We included patients who were alive at arrival to CAPTURES hospitals. Those with unknown information on post-resuscitation outcomes were excluded. Exposure variable was route of arrival to hospital (direct or transferred). Primary outcome was survival to discharge, and secondary outcome was good neurologic outcome (cerebral performance category of 1 or 2) at discharge. A multivariable logistic regression analysis was conducted to estimate the risk of inter-hospital transfer on outcome variables. Potential confounders were gender, age, witnessed status, bystander CPR, initial arrest rhythm, and post-resuscitation care (therapeutic hypothermia and primary coronary intervention). **Results:** A total of 249 OHCA patients were analyzed. Survival rate to hospital discharge was higher in the direct group ($n = 104$) than in the transferred group ($n = 145$) (91.0% vs. 64.8%, $p < 0.01$). Similar results were observed with rates of good neurologic outcome (86.0% vs. 43.2%, $p < 0.01$). Inter-hospital transfer was associated with both decreased survival (AOR 0.32, 95% CI 0.14-0.71) and recovery of neurologic function (AOR 0.13, 95% CI 0.06-0.31). **Conclusion:** Inter-hospital transfer was associated with an increased risk of poor post-resuscitation outcomes of OHCA. A safer inter-hospital transfer system should be considered.

45. 9-1-1 CALLER DESCRIPTIONS OF ABNORMAL BREATHING DURING OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Abnormal breathing, or "gasp-ing," frequently occurs during cardiac arrest and has been associated with increased survival. During 9-1-1 calls, early recognition of gasping may allow dispatchers to identify OHCA and to start CPR instructions promptly. **Objective:** To characterize lay rescuers' descriptions of abnormal breathing during OHCA. **Methods:** The 9-1-1 audio recordings of 4,279 confirmed OHCA's (10/10-7/14) in Arizona were reviewed by program personnel. Terms used by lay rescuers to describe victims' breathing were recorded in a structured database. **Results:** Abnormal breathing (as opposed to "not breathing") was described in 542/4279 (13%) calls. There were 623 verbal descriptions. A total of 50 different terms were used. However, the top 8 accounted for 83% and the remaining 42 descriptions ("Other") comprised only 17% of all terms used. "Gasping" was the most commonly used term (30%; 187/623), followed by "snoring" (15%; 95/623). **Conclusion:** Lay rescuers used a wide variety of terms to describe abnormal breathing in documented OHCA. However, 8 terms accounted for 83% of descriptions. Familiarizing 9-1-1 telecommunicators with the most commonly used terms may improve the accuracy of recognition and hasten the identification of OHCA.

46. DISPATCHER-ASSISTED CARDIOPULMONARY RESUSCITATION PROGRAM AND OUTCOMES AFTER PEDIATRIC OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Dispatcher-assisted bystander cardiopulmonary resuscitation (DA-BCPR) is expected to influence the outcomes of pediatric out-of-hospital cardiac arrest (OHCA). **Objective:** We investigated and compared the association and the effect size of DA-CPR on survival outcomes according to location of the event. **Methods:** All EMS-treated OHCA's less than 19 years of age in Korea were analyzed from January, 2012 through December, 2013, excluding patients witnessed by EMS providers or missing outcome information. Exposure groups were No-BCPR group for patients who did not receive BCPR, BCPR-NDA group for patients who received BCPR without DA, and BCPR-DA for patients who received DA-BCPR. The endpoint was survival to discharge. Multivariable logistic regression analysis was performed to calculate the adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for outcomes by exposure group (reference = No-BCPR group) with and without an interaction term between exposure and location of arrest. **Results:** A total of 1,013 eligible patients were finally analyzed. Among these patients, 39.8% had received BCPR (16.6% BCPR-NDA and 23.2% BCPR-DA). The survival to discharge rate was significantly higher in BCPR-NDA (10.7%) and BCPR-DA (9.0%) compared with No-BCPR group (4.3%) ($p = 0.002$). AORs (95% CI) for survival to discharge compared with No-BCPR group were 1.73 (1.03-3.12) in BCPR group, 1.71 (0.85-3.46) in BCPR-NDA, and 1.39 (0.72-2.69) in BCPR-DA group, respectively. The AORs (95% CI) of BCPR-NDA and BCPR-DA in public locations were 3.30 (1.12-9.72) and 2.95 (1.00-8.67) while BCPR-NDA and BCPR-DA in private locations were 1.62 (0.68-3.88) and 1.15 (0.53-2.51), respectively. **Conclusion:** The DA-CPR was associated with better outcomes in pediatric OHCA patients whose arrest occurred in a public location, but not in a private location.

47. OUTCOMES WITH DISPATCHER ASSISTED BYSTANDER CPR INSTRUCTIONS

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Background: Out-of-hospital cardiac arrest survival rates improve with the timely provision of bystander cardiopulmonary resuscitation (CPR). An increased frequency of early intervention through bystander CPR has been demonstrated after the implementation of dispatcher assisted CPR programs in several United States cities. **Objective:** To determine the role patient age plays in receiving bystander CPR in communities with an established dispatcher CPR program. **Methods:** A retrospective study was performed on all out-of-hospital cardiac arrest patients in three communities which provided dispatcher-assisted CPR instructions. Two cities provided dispatcher CPR according to a local protocol and one used Priority Medical Dispatch. The County-wide EMS database was accessed and data for all EMS treated cardiac arrest cases occurring between 7/1/2012-5/31/15 was abstracted. This database included EMS documentation of whether bystander CPR was provided and the patient's age. Hospital reported survival to discharge was also included in the EMS database. Age was categorized into three groups: 0-12, 13-54, and >55 years. Chi Square was used to compare bystander CPR rates by patient age. **Results:** Overall, there were 199 cases of bystander CPR performed in the dispatcher as-

sisted CPR cities. Bystander CPR was provided for 9.94% and the overall survival rate was 10.85%. The highest rates of bystander CPR occurred in the 0–12 age group (16.9%) and lowest in the >55 group (8.84%). The 13–54 age group had a bystander rate of 10.98%. There was a statistically significant difference in bystander CPR by age $p < 0.04$. **Conclusion:** The rate of EMS documented bystander CPR was low even though these cities provided dispatcher-assisted CPR. The highest rates of bystander CPR were observed in the youngest age group, demonstrating that bystanders are more likely to perform dispatcher-assisted CPR on younger individuals. Future investigations should determine if there are ways to change dispatcher messaging to improve CPR rates across different age groups.

48. THE CLINICAL COURSE AND OUTCOME OF PATIENTS IDENTIFIED AS A MEDICAL PRIORITY DISPATCH SYSTEM (MPDS) CARD 10 (CHEST PAIN)

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Background: Few studies have described the clinical course/outcome of specific cohorts of patients identified by their 9-1-1 call. Card 10 (chest pain) patients are important due to the time sensitive nature of cardiac related treatment. **Objective:** To describe the clinical course and outcome of patients identified as an MPDS Card 10, including the positive predictive value (PPV) with primary Emergency Department (ED) diagnosis. The study setting consists of a dispatch center that is an Accredited Center of Excellence by the National/International Academies of Emergency Dispatch serving a population of 105,000, an annual call volume of 12,000, and dispatching 16 units over a 46,000sq/km area. **Methods:** All 9-1-1 calls rated as a Card 10 pertaining to a patient ≥ 16 years of age were linked with their health outcomes using a deterministic strategy. Descriptive analysis of their clinical course and PPV of the MPDS Card 10 using primary ED diagnosis as the gold standard are provided. **Results:** A total of 616 Card 10 calls out of 20,683 total calls (3.0%) were received between November 1, 2011 and July 31, 2013, with 570 (92.5%) patients successfully linked to their ED records. The median (IQR) age of this sample was 71 (24), with 274 (48.1%) female. There was 1 (0.2%) patient that died in the ED, 6 (1.1%) who left without being seen, 360 (63.2%) discharged alive, and 203 (35.6%) admitted as an in-patient. Of those admitted as an in-patient, 197 (97.0%) could be linked to their records; the median (IQR) age was 74 (21), with 79 (40.1%) female. There were 8 (4.1%) patients that died, and 189 (96.0%) were discharged or transferred to long-term care facilities alive. Of the 570 linked ED patients, 318 had a primary ED diagnosis related to a cardiac condition resulting in a PPV of the MPDS Card 10 to detect a cardiac event in the ED of 55.8% (95%CI 51.6%–59.9%). The top three ED diagnoses for the 252 patients without a cardiac diagnosis were anxiety disorder (6%), COPD (5.6%), and abdominal pain (5.2%). **Conclusion:** Almost half of MPDS Card 10 patients do not have a primary ED diagnosis related to a cardiac condition. These results are important to improve the detection of cardiac patients that may potentially benefit from time sensitive treatment.

49. SENSITIVITY, SPECIFICITY, AND PREDICTIVE VALUES OF EMERGENCY MEDICAL SERVICE PROVIDER ASSESSED CARDIAC SYMPTOMS ON ACUTE MYOCARDIAL INFARCTION

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Background: For acute myocardial infarction (AMI) patients, emergency medical service (EMS) provider assessed symptoms have critical role in prehospital treatment decisions. The purpose of this study was to evaluate the diagnostic performance of EMS assessed symptoms of cardiovascular disease for actual AMI. **Methods:** Patients from 2008 to 2012 transported to 4 study hospitals by EMS were included. Using EMS records and ED database, all patients were stratified according to the presence of EMS assessed cardiac symptoms and ED diagnosis of AMI. Cardiac symptoms were defined as chest pain, dyspnea, palpitation, and syncope. Disproportionate stratified sampling was used, and hospital records of sampled patients were reviewed to identify the actual diagnosis of AMI. Using the inverse probability weighting, verification bias-corrected diagnostic performance was estimated. **Results:** Overall, 92,353 patients were enrolled for the study. Of these, 13,971 (15.1%) complained of cardiac symptoms to the EMS provider. Of all included, 1,001 (1.08%) had an ED diagnosis of AMI. 775 patients were sampled for hospital record review. The sensitivity of EMS provider assessed cardiac symptoms on the final diagnosis of AMI was 73.3% (95% CI: 70.8–75.7), specificity was 85.3% (95% CI: 85.3–85.4), positive predictive value was 3.9% (95% CI: 3.6–4.2), and negative predictive value was 99.7% (95% CI: 99.7–99.8). Diagnostic performance of each cardiac symptom was also estimated. **Conclusions:** We found that EMS provider assessed cardiovascular symptoms had moderate sensitivity and specificity for diagnosis of AMI. EMS policy makers can use these data to evaluate the appropriateness of specific prehospital treatments for AMI.

50. PREHOSPITAL CATHETERIZATION LABORATORY FALSE ACTIVATION FOR SUSPECTED STEMI BASED ON A TRANSMITTED 12-LEAD ECG

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Background: Prehospital activation of catheterization laboratory for suspected STEMI is associated with a shorter door-to-balloon time. When activation is made from the Emergency Department, there is a Catheterization Laboratory False Alarms (CLFA) rate of between 7.2% and 14%. However, the CLFA rate of a prehospital activation made remotely by an emergency physician based on a transmitted 12-lead ECG has not been well studied. We evaluated the CLFA rate of this approach and measured time from first positive ECG to the beginning of the coronary angiography. **Methods:** This is a retrospective cohort study of 673 patients with suspected STEMI who were diverted to the nearest PCI-capable hospital according to an emergency physician interpretation of a 12-lead ECG transmitted by paramedics. CLFA was defined as a diverted patient who had a coronary angiography without signs of a clear culprit coronary artery. False-positive rate was defined as the rate of patients for whom final diagnosis was not considered to be a STEMI. The coronary angiography beginning time was defined as first arterial puncture. **Results:** Among the 673 patients which were diverted, 640 underwent coronary angiography. 62 of them did not have a culprit coronary artery, representing a CLFA rate of 9.7%. In the remaining 33 patients, 13 had a confirmed STEMI by cardiologists but underwent medical or palliative treatment. The other 20 patients had a final diagnosis other

than STEMI, representing a false-positive rate for STEMI of 12.2% among the entire cohort (62 + 20). Average time from first positive ECG to the beginning of the coronary angiography was 58.9 (+/–18.4) minutes. A total of 593 patients (92.7%) had a coronary angiography within 90 min after the first positive ECG. **Conclusion:** Prehospital catheterization laboratory activation by an emergency physician based on a transmitted ECG for patients with suspected STEMI is not associated with an increase in CLFA rate. This approach is known to decrease reperfusion delay and could increase the number of patients eligible for a PCI as the primary reperfusion strategy without increasing the rate of CLFA.

51. EFFECT OF AVAILABILITY OF COMPUTER ECG ANALYSIS ON THE ACCURACY OF PARAMEDIC PCI LAB ACTIVATION FOR STEMI

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Background: Computer algorithms for ECG interpretation in the prehospital setting have been previously studied but little field data exists on a paramedic's recognition of STEMI with and without the assistance of the computer interpretation. **Methods:** We analyzed each 12-lead ECG obtained in this mid-sized suburban EMS system for two consecutive months; one month with the interpretation available and one without. We recorded the paramedic's interpretation of each ECG and whether or not they activated the cath lab. A single patient may have received multiple ECGs. Paramedics were not given any instructions as to how to use the interpretation. Each ECG was read by the EMS medical director and by a cardiologist. The interpretation was binary: either a STEMI was or was not present. Any discrepancies between physicians were resolved by a tie-breaking read by an additional cardiologist. The consensus of two out of three physicians was considered the "gold standard." **Results:** There were a total of 1,389 12 lead ECGs obtained during the study period. A total of 703 (50.6%) of the total ECGs had the interpretation available to the paramedic. ECGs were correctly classified by machine, by paramedic and by both 97%, 94%, and 98%, respectively. Sensitivity and specificity were 81%/97% for machine, 56%/95% for paramedic and 88%/98% for both. False positive and false negative rates were 3%/19% for machine, 5%/44% for paramedic, and 2%/13% for paramedic with machine. Prevalence of STEMI in each group was 1% for paramedic only and 2% for the other two groups. Positive and negative predictive values were 37%/100% for machine, 13%/99% for paramedic, and 52%/100% for both. **Limitations:** The paramedic had clinical information available to them that the physicians did not, which likely influenced their actions. The lack of clinical data by physicians may have led to the large false negative rate by paramedics. Additionally, the study only looked at ECG interpretation; no outcomes were evaluated. **Conclusion:** In this EMS system, the availability of the machine interpretation in combination with paramedic judgment improved diagnostic accuracy when compared with either alone.

52. THE EFFECT OF EMERGENCY MEDICAL SERVICE USE AND INTER-HOSPITAL TRANSFER ON PREHOSPITAL DELAY AMONG ISCHEMIC STROKE PATIENTS: A MULTICENTER OBSERVATIONAL STUDY

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Background: The time between symptom onset and arrival at an emergency department (ED) (S2D) is a crucial time for optimal intravenous reperfusion care for ischemic stroke. We aimed to analyze the effect of emergency medical services (EMS) utilization and inter-hospital transfer on S2D in Korea. **Methods:** Ischemic stroke patients were prospectively enrolled from November 2007 to December 2012 in 23 tertiary and teaching hospital EDs in South Korea. Of 31,443 adult ischemic stroke patients, 20,780 were categorized into 4 groups based on modes of EMS utilization and inter-hospital transfer. **Results:** Direct transport to destination ED by EMS (EMS direct; $n = 6,257$, 30.1%), transfer after transport to another ED by EMS (EMS indirect; $n = 754$, 3.6%), direct transport to the ED without using EMS (non-EMS direct; $n = 8,928$, 43.0%), and transfer after visiting another hospital without using EMS (non-EMS indirect; $n = 4,841$, 23.3%). Our primary outcome variable was of S2D within 2 hours ($S2D \leq 2h$) and found that 30.8% of all patients and 52.3%, 16.4%, 25.9%, and 13.9% of EMS direct, EMS indirect, non-EMS direct, and non-EMS indirect, respectively, achieved $S2D \leq 2h$. Adjusted odds ratio for $S2D \leq 2h$ were 6.56 (95% confidence interval [CI] 5.94–7.24), 2.27 (95% CI 2.06–2.50), and 1.07 (95% CI 0.87–1.33) for EMS direct, non-EMS direct, and EMS indirect, respectively. **Conclusion:** Patients directly transported to destination hospitals by EMS showed the highest proportion of therapeutic time window for optimal care in ischemic stroke.

53. EVALUATING THE IMPACT OF A NOVEL MOBILE CARE TEAM (MCT) ON THE PREVALENCE OF AMBULATORY CARE SENSITIVE CONDITIONS PRESENTING TO EMERGENCY MEDICAL SERVICES IN NOVA SCOTIA

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Background: Hospitalization due to ambulatory care sensitive conditions (ACSC) is a proxy measure for access to primary care. Emergency medical services (EMS) are increasingly called when primary care cannot be accessed. A novel paramedic-nurse EMS Mobile Care Team (MCT) was implemented in an underserved community. The MCT responds in a non-transport unit to bookings from EMS, emergency and primary care and to low-acuity 9-1-1 calls in a defined geographic region. Our objective was to compare the prevalence of ACSC in ground ambulance (GA) responses before and after the introduction of the MCT. **Methods:** A cross-sectional analysis of GA and MCT patients with ACSC (determined by chief complaint, clinical impression, treatment protocol, and medical history) one year pre- and one year post-MCT implementation was conducted for the period Oct. 1, 2012 to Sept. 30, 2014. Demographics were described. Predictors of ACSC were identified via logistic regression. Prevalence was compared with chi-squared analysis. **Results:** There were 975 calls pre- and 1208 GA/95 MCT calls post-MCT. ACSC in GA patients pre- and post-MCT was similar: $n = 122$, 12.5% vs. $n = 185$, 15.3%; $p = 0.06$. ACSC in patients seen by EMS (GA plus MCT) increased in the post-period: 122 (12.5%) vs. 204 (15.7%) $p = 0.04$. Pre vs post, GA calls differed by sex ($p = 0.007$) but not age (65.38 ± 15.12 vs. 62.51 ± 20.48 ; $p = 0.16$). Post-MCT, prevalence of specific ACSC increased for GA: hypertension ($p < 0.001$) and congestive heart failure ($p = 0.04$). MCT patients with ACSC were less likely to have a primary care provider compared to GA (90.2% and 87.6% vs. 63.2%; $p = 0.003$, $p = 0.004$). **Conclusion:** The

prevalence of ACSC did not decrease for GA with the introduction of the MCT, but ACSC in the overall patient population served by EMS increased. It is possible more patients with ACSC call or are referred to EMS for the new MCT service. Given that MCT patients were less likely to have a primary care provider this may represent an increase in access to care, or a shift away from other emergency/episodic care. These associations must be further studied to inform the ideal utility of adding such services to EMS and healthcare systems.

54. HIV POINT OF CARE TESTING BY COMMUNITY PARAMEDICS IN A VULNERABLE POPULATION: A PILOT STUDY

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Background: Literature suggests that up to 25% of people with HIV in North America are unaware of their status, and are at risk to transmit the virus unknowingly. A high proportion of HIV patients are diagnosed when the disease is more advanced with CD4 counts < 200 . This study examined the rates of HIV testing, detection and treatment of clients at an inner city shelter and detoxification center after the introduction of a POCT program by on site CP. **Methods:** In 2013, in collaboration with a regional HIV program, CP received training in and instituted an HIV POCT and post-test counselling initiative. A retrospective electronic database review from October 16, 2013 to October 15, 2014 of adult patients who received HIV POCT was performed. Demographic and testing details of each patient encounter were abstracted and select variables were compared to a historic population who received POC HIV testing at an inner city emergency department (ED) study in the same city. **Results:** 1,207 HIV POCT were performed on 997 patients during the pilot. 57% of patients tested were less than 40 years of age (range 18–73 years), compared to 55% in the historic ED population. A total of 9 reactive cases were identified in the study population including 3 new cases, 5 previously known cases and 1 false reactive result. The mean age of new cases was 47 vs. 44 in the historic control. All three new HIV cases were referred to a local HIV clinic for further care and treatment. New HIV cases represented 0.25% of total tests performed, which is lower than both the expected prevalence rate of 1% for this population, as well as, the rate of 1.4% found in the ED population. **Conclusion:** Despite lower than expected reactive rates, large scale implementation of a CP HIV POCT program in an inner city shelter and detoxification center is feasible. All patients with new reactive tests were immediately connected to care. Future research will focus on risk factors and barriers to testing.

55. COST-EFFECTIVENESS ANALYSIS OF COMMUNITY PARAMEDICINE PROGRAM FOR PATIENTS WITH HEART FAILURE

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Background: Heart failure is a condition that has a high hospital readmission rate; this greatly increases health care cost. Community paramedicine (CP) programs may decrease readmission rate of patients with heart failure and reduce hospital cost. However, a cost-effective analysis of the program has not been well studied. This study aimed to conduct a cost-effective analysis of CP program in patients with heart failure compared with routine care. **Methods:** We performed a retrospec-

tive observational study between April 2014 and November 2014 when our EMS agency conducted a pilot project of CP program. Decision analysis model was used to analyze a cost-effectiveness analysis between CP program and the routine care. Furthermore, a sensitivity analysis was performed to observe an effect of readmission rate of CP program to Incremental Cost-Effectiveness Ratio (ICER). **Results:** Forty hundred thirty five individuals were identified as heart failure patients discharged from hospital during the time frame. The CP program provided a comprehensive care to 8 of these patients and none were readmitted within 30 days (0%, 95%CI 0%–31%). The average cost of the CP program was \$66 per patient. The remaining 427 patients received routine care plan with 101 patients readmitted (24%, 95%CI 20%–28%). The average hospital cost was \$7,900 per patient. Based case analysis revealed the CP program saved \$7,625 per patient reduced readmission. However, sensitivity analysis demonstrated that the CP program dominated the routine care only when the readmission rate of CP program was lesser than the routine care. If the CP program had 10% readmission, on average individuals saved \$7,428.57. However, when readmission of patients in CP program reaches 30%, it is not cost-effectiveness. And the routine care plan saved hospital cost more than the CP program (\$9,000 saving per patient reduced readmission). **Conclusion:** The CP program was an effective program to reduce readmission rate among patients with heart failure and to reduce hospital cost. Readmission rate of the CP program was a critical factor to determine the cost-effectiveness. Therefore, the CP program should have readmission rate lesser than the routine care plan to maintain cost-effectiveness.

56. EVALUATION OF PATIENT ATTITUDES TOWARD TYPES OF MOBILE INTEGRATED HEALTHCARE PROVIDERS

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Background: Mobile integrated healthcare (MIH), aka community paramedicine, is a cost-effective supplement to traditional healthcare services. With lower reimbursements for readmissions, MIH models are developing as possible solutions. Previous literature documents the effectiveness of MIH, but minimal is known regarding patients' perspectives toward this new healthcare delivery model. **Objective:** To evaluate the comfort of patients toward home healthcare (HHC)/MIH and its types of providers. **Methods:** Setting: Urban tertiary care emergency department. **Methods:** Medically stable patients 50 years and older who had the capacity to answer survey questions. Participants were surveyed regarding their comfort towards receiving HHC/MIH and to the type of provider (i.e., nurse vs. prehospital provider [PHP]). A Likert Scale was used to gauge responses (1 = Not Comfortable, 10 = Very Comfortable). No personal identifiers were recorded. Statistical significance was set a priori at < 0.05 . The study was deemed exempt by the IRB. **Results:** Of the 377 patients surveyed, 27% were Caucasian, and 70% African-American. 90.5% of patients were willing to accept HHC. When comparing comfort with a nurse vs. PHP, the overall mean was 8.64 vs. 8.12 ($p = 0.002$) and median was 10 vs. 9 ($p = 0.015$), respectively. For Caucasians, the mean was 8.64 vs. 8.13 ($p = 0.089$) and median was 10 vs. 9 ($p = 0.182$), respectively. For African-Americans, the mean was 8.65 vs. 8.14 ($p = 0.012$), but the median was 10 vs. 9 ($p = 0.064$), respectively. Only 3% reported a score lower than 5 for a nurse

compared to 8.7% for a PHP. Of those in the latter group, 40% reported a score of 10 and 60% reported a score of 7 or higher for a nurse. Comments revealed a preference for nurses in receiving MIH due to higher "trust" of nurses administering tests. **Conclusion:** The vast majority of patients are willing to accept HHC. A statistically significant preference exists overall for nurses over PHPs. For Caucasians, no preference exists. For African-Americans, a preference is not definitive. Further research should investigate reasons for the overall preference for nurses over PHPs. MIH programs should focus on increasing patients' comfort with PHPs and educating them on the advantages of MIH.

57. EFFECTIVENESS OF THE "TRANSPORT PLUS" INTERVENTION: HOME FALL HAZARD ASSESSMENT

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Background: Older adult patients experience high rates of falls following hospitalization. "Transport PLUS" expands the role of Emergency Medical Technicians (EMTs) by adding simple interventions to routine ambulance transports home from the hospital to improve population health. This study evaluates the effectiveness of an in-home Fall Hazard Assessment (FHA). Previously reported feasibility data demonstrated 73.1% patient acceptance of the intervention with a mean of 2.54 unique hazards found per assessment. **Objective:** To test the hypothesis that a significant proportion of patients receiving the "Transport PLUS" FHA will make a change to the home environment to reduce the risk of falls. **Methods:** As part of a demonstration project conducted between November 2013 and June 2014, a convenience sample of patients over 65 transported directly home from the hospital by ambulance, after inpatient or ED discharge, received the Transport PLUS FHA. The intervention consisted of an EMT assessing the home for hazards using an 11-item checklist and providing educational information on fall risk mitigation. Phone surveys at 2-4 weeks post-intervention measured patient/caregiver satisfaction and whether the patient or family made a change to the home environment to reduce the risk of falls. Secondary evaluations were performed by community health workers (CHW's) on a select sample of patients to validate accuracy of the initial EMT assessment and changes made to the home environment. **Results:** Out of 320 FHA's performed, 183 (57.1%) patients and/or caregivers were successfully surveyed over the phone. 89.8% found the FHA helpful and 50.3% reported making a change to the home environment. The 49 CHW home visits yielded an overall 98.8% concordance with the hazard assessments performed by EMT's. Of the 30 patients within the validation subgroup that reported making a change to the home environment, the CHW's were able to validate that 26 (86.7%) actually removed the hazard. **Conclusion:** This study demonstrates high rates of patient satisfaction and clinical effectiveness of the FHA component of Transport PLUS. These results were validated by high rates of concordance between the EMT and CHW assessments and between the patient self-report of making a change to the home environment and subsequent CHW confirmation.

58. PARAMEDICS PROVIDING PALLIATIVE CARE AT HOME: AN EVALUATION OF PARAMEDIC COMFORT AND CONFIDENCE IN PROVIDING PALLIATIVE SUPPORT

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Background: Paramedics are sometimes called for crisis management and relief of symptoms or for patients receiving palliative care. To address the mismatch between the system protocols and resources, and patient's goals of care, a new protocol, new medications, and an 8-hour training program Learning Essentials Approach to Palliative Care (LEAP) were implemented in our provincial EMS system. **Methods:** Prior to attending their training session paramedics received an invitation to complete an online survey regarding their comfort, confidence, and attitudes toward delivering palliative care. Comfort and confidence questions were scored on a 4-point Likert scale, while attitudes toward specific aspects of care were scored on a 7-point Likert scale. Descriptive statistics were calculated. Identifiers will permit linkage of these responses to a repeat survey post-implementation. **Results:** A total of 188 (58%) paramedics completed the survey of the 325 who opened the link; 134 (68%) were male with a mean age of 38.5 years; and 95 (50%) were primary care paramedics. The average experience as a paramedic was 12.7 years, with an estimated mean number of palliative calls per year of 9.6 each. Most (156, 83%) were comfortable with providing care to someone with palliative goals, and 130 (69.1%) were comfortable providing care without transport. Only 82 (43.6%) were confident they had the tools to deliver this care, and 76 (40.4%) were confident they could do so without transport to hospital. **Conclusions:** Prior to the implementation of the new protocol, medications, and training, most paramedics were comfortable with the concept of providing care with palliative goals, but they were not confident that they have the tools and resources to do so. This suggests paramedics would be open to system improvements to meet an unmet healthcare need for crisis management of patients with palliative goals of care.

59. STATE OF THE EVIDENCE FOR EMERGENCY MEDICAL SERVICES (EMS) PROVISION OF PALLIATIVE CARE: AN ANALYSIS OF APPRAISED RESEARCH FROM THE CANADIAN PREHOSPITAL EVIDENCE-BASED PRACTICE (PEP) PROJECT

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Background: Patients who require end of life (EoL)/palliative care occasionally need assistance from paramedics. An expansion of paramedic palliative care support is occurring in some emergency medical services (EMS) systems. This review evaluated the evidence for paramedic-delivered EoL/palliative care interventions. **Methods:** The Canadian Prehospital Evidence-based Practice (PEP) Project methodology was used. A PubMed search was conducted, using Medical Subject headings and title/abstract key words. Titles and abstracts were reviewed for relevance. Studies were not required to be EMS based but must have focused on interventions available to EMS personnel. Included full text studies were scored by trained primary appraisers on a three-point Level of Evidence (LOE) scale (on study design and quality: high = 1, moderate = 2, and low = 3) and three-point Direction of Evidence (DOE) scale (supportive, neutral, or opposing). Each appraisal was reviewed by a senior appraiser. Studies were categorized by clinical condition

(n = 5) and by intervention (n = 25), and plotted on 3 × 3 (DOE × LOE) tables. The study primary outcome and setting were determined. **Results:** The search returned 3255 articles; 86 were selected for abstract review, with 30 full text articles ultimately included. Intervention recommendations were: LOE 1-supportive (n = 3, 12%), 2-supportive (n = 2, 8%), 3-supportive (n = 2, 8%), 1-neutral (n = 2, 8%), 2-neutral (n = 2, 8%), 3-neutral (n = 4, 16%). No primary studies were identified for 10 (40%) interventions. Conditions with 1-supportive studies were: "breathlessness" and "analgesia." "Secretions" condition had no relevant evidence. Interventions with 1-supportive evidence were: Haldol for agitation (n = 1), fentanyl and morphine for analgesia (n = 3 and n = 1), narcotics for breathlessness (n = 1). No intervention had opposing evidence. Primary outcomes were more commonly related to symptom relief (n = 26, 87%), safety (n = 3, 10%), or tolerability (n = 1, 3%). Only one included study was conducted in the EMS setting. **Conclusion:** Evidence for interventions used by paramedics in the treatment of patients requiring EoL/palliative care was identified, as were evidence gaps. A minimal amount of research was conducted in the EMS setting, and most interventions had few studies. These PEP findings highlight topics requiring high quality EMS research specific to EoL/palliative care to inform this growing aspect of paramedic practice.

60. ESTIMATING PALLIATIVE SUPPORT NEED AMONG EMS PATIENTS

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Background: Palliative support has not traditionally been part of the emergency medical services (EMS) scope of practice, despite EMS often caring for patients at the end of life. Standard EMS practice may conflict with palliative patient wishes as many may not want aggressive lifesaving interventions. Our objective was to develop a measure to quantify and describe the population that may benefit from EMS palliative support. **Methods:** A provincial EMS electronic patient care record database was queried for all emergency ground ambulance calls between January and March 2014. Three data fields were identified as potential indicators of palliative need: 1) history of specific diseases that may benefit from palliative support, 2) chief complaint associated with palliative support, and 3) an advance directive or do not resuscitate order present. A Palliative Support Composite Measure (PSCM) was developed with four categories to classify calls as: probable palliative (EMS records with all three indicators present), potential palliative (two of the three indicators), low potential palliative (one indicator), and non-palliative (no indicators). Descriptive statistics were reported, with comparisons made across the PSCM categories using demographic and EMS call outcome variables. **Results:** There were 19,487 EMS calls. Mean patient age was 59.6 years, with 7,918 (40.6%) patients older than 70. Of all calls, 6,385 (32.8%) had a history of one or more of the PSCM diseases, 11,548 (59.2%) had a complaint associated with palliative care and 326 (2%) had an advance directive or do not resuscitate order. By applying the PSCM, 201 (1%) calls were classified probable palliative, 4,388 (22.5%) potential palliative, 8,880 (45.6%) low potential palliative, and 6,018 (30.9%) non-palliative. Probable palliative calls involved patients who were older, more likely to be female, long term care residents, be of higher acuity, and die on scene. **Conclusion:** Probable and potential palliative EMS patients were recognized using a measure

to retrospectively identify EMS patients who may benefit from EMS palliative support. The study findings can help inform EMS palliative support training and program planning. Research is recommended to further validate and refine the PSCM and to identify palliative population utilization of EMS.

61. CHARACTERISTICS OF USAGE OF EMERGENCY MEDICAL SERVICES BY PATIENTS WITH ADVANCED CANCER LIVING IN THE COMMUNITY: A RETROSPECTIVE MEDICAL RECORD REVIEW

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Background: In Canada, an increasing number of citizens are living longer, in the community, with advanced, non-curable cancer. Accordingly, Emergency Medical Services (EMS) are encountering more of these patients, many of whom have chosen to receive end of life care at home. Given that the delivery of palliative care and EMS has tremendous regional variability, our group's objective was to examine the characteristics of EMS interactions of patients with advanced cancer living in the community in a Canadian urban area. A secondary objective was to identify themes that may lead to practice changing guidelines or education opportunities for EMS providers to better care for this unique patient population. **Methods:** We conducted a retrospective medical record review on 100 patients with stage 3 or 4 cancer who died within 3 months of activating an EMS response. A standardized template was developed with explicit variable definitions and data was analyzed using SPSS software. The study was approved by the Ottawa Hospital Research Ethics Board. **Results:** The average age of patients was 70.5 years and 59% were male. The majority (85%) of patients lived at home; 95% of patients had a family doctor; 36% had previously been seen by a palliative care physician, whereas 62% had ongoing care with their oncologists; and 41% had active chemotherapy at the time of their 9-1-1 call. The most common cause for EMS activation was for generalized weakness (25%), pain (21%), and dyspnea (16%). 5% of the calls were related to cardiac arrest. The most common interventions provided by paramedics (excluding ECGs, oxygen, and starting an intravenous) were administering analgesia (6%), anti-emetics (7%), and ACLS medication (4%). Upon Emergency department (ED) presentation, 81% were admitted to hospital, of which 8% to ICU; 8% patients died in Emergency Department (ED); and 11% were discharged home. Most patients (69%) died in the acute care hospital. This is one of the first studies that examined patients with advanced cancer living in the community and the reasons they activated EMS. We feel the themes identified will lead to future research in this area and also to practice changing protocols for prehospital providers.

62. FEASIBILITY OF EMERGENCY TELEMEDICINE TO REDUCE UNNECESSARY AMBULANCE TRANSPORTS AND EMERGENCY DEPARTMENT VISITS

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Background: In emergent medical situations, there are limited alternatives to EMS or Emergency Department (ED) visits particularly during off hours. This problem is magnified in skilled nursing facilities (SNF) where the only option for emergent medical evaluation maybe

to call an ambulance and transport the patient to the ED. **Objective:** To pilot the feasibility, efficiency and safety of an on-call Emergency Telemedicine Service (ETS) staffed by Board Certified EM physicians with an expertise in EMS in order to reduce the need for ambulance transports and ED visits. **Methods:** A novel telemedicine App and interface was developed for the pilot project. The staff at a selected SNF was trained to use the ETS similar to how they would call the patient's physician in non-life threatening emergencies. Patients were evaluated and treated by the ETS with the aid of the staff at the SNF including a review of the patient's medical history and medications. Key quality metrics including time interval and patient outcomes were tracked. A quality improvement (QI) committee consisting of EMS experts, Physicians, and Nurses reviewed each case for safety, potential delays and appropriateness of care. All data was entered into Microsoft excel. Descriptive statistics are reported for the pilot project. **Results:** Ten patients were seen by the ETS during the pilot phase. Only three patients were transported to the ED by EMS. The time from ETS to EMS activation was less than 2 min in all cases. The QI committee reviewed both cases and felt there was no significant delay in the care or potential harm from not directly activating 9-1-1 by the SNF. Seven of the ten patients were successfully managed in the SNF without transport. Prior to the pilot, all ten patients would have required ambulance transport to the ED. **Conclusion:** The use of an ETS may be a feasible, efficient, and safe for patients in a SNF suffering from emergent medical conditions and may avoid unnecessary ambulance transports and ED visits. Further investigation needs to be done to understand the scope of practice, safety, and potential cost savings of an ETS in this and other settings.

63. MULTI-CENTER EVALUATION OF A LOW ACUITY EMS TRIAGE PROTOCOL

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Background: Currently, safe and effective Emergency Medical Services (EMS) triage algorithms for transport of low acuity patients to alternative destinations have not been well established. Recently, a low acuity triage protocol was implemented in the region to allow for expedited EMS handoff procedures to reduce turnaround times in the ED. This protocol, although not developed for alternative destinations, shows promise at effectively identifying patients who are appropriate for care at urgent care centers. **Objective:** To test the hypothesis: Patients identified by EMS providers using the Fast Track Triage (FTT) protocol are likely to be appropriate for evaluation and treatment at an urgent care center. **Methods:** This is a retrospective cohort study of patients identified as low acuity by EMS providers using the FTT protocol at three urban teaching hospitals between September 2014 and February 2015. The protocol specifies 24 medical complaints for inclusion along with 8 exclusion criteria. Charts of identified patients were abstracted in a structured manner for information about the clinical presentation, disposition, diagnostic testing and therapeutic interventions performed. Two independent and blinded urgent care physicians (KMN, JF) then reviewed this data to determine if cases were appropriate for treatment at an urgent care facility. Disagreements between the two physicians were adjudicated by independent review by the principle investigator (PI). **Results:** During the study

period, a total of 177 total patients were identified by EMS using the FTT protocol. "Minor contusion/strains/sprains" was the most common inclusion criteria, followed by "lacerations" and "arthralgia / joint pain." Upon initial review, the two independent urgent care physicians determined 137 patients (77%) and 156 patients (88%) were appropriate for urgent care with disagreements in 33 cases (kappa of 0.41 indicating moderate agreement). After adjudication, a final result of 153 patients (86%) was determined to be appropriate for urgent care. When stratified by site, 77%, 85%, and 91% of patients were deemed appropriate for urgent care. **Conclusion:** This study demonstrated significant potential of a low acuity EMS triage protocol to identify patients who might be appropriate for urgent care. Further analysis will hopefully lead to refinements of the EMS low acuity protocol to reduce under triage rates.

64. AN INTERNATIONAL COMPARISON OF OPERATIONAL AND CLINICAL ASPECTS OF EMS SYSTEMS

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Background: EMS systems differ among countries and regions. However, the mission of pre-hospital care is the same everywhere: to provide timely and effective emergency care to the public. Identifying factors that affect operational aspects in various EMS systems may help improve international EMS systems as a whole. **Objective:** To compare prehospital time intervals and interventions for five patient conditions across EMS systems in seven countries. **Methods:** This is a descriptive, retrospective study involving data from ten regions in seven countries (New Haven USA, Tokyo/Osaka/Okinawa/Sapporo Japan, Seoul Korea, Taipei Taiwan, Manchester UK, New South Wales (NSW) Australia, Nova Scotia Canada). Each participating city/region provided dispatch data (times call received at dispatch center, EMS unit arrived on scene, EMS unit left scene, and arrival at hospital) for 10 to 30 patients each with chest pain, dyspnea, stroke, major trauma, and cardiac arrest. Service demographic and intervention data were collected. Means of the time intervals were calculated and compared. **Results:** The average total interval from dispatch to hospital arrival ranged from 20.8 min (Taipei) to 58.7 min (Nova Scotia). On-scene interval ranged from 7.5 min (Seoul) to 31.9 min (Manchester). Across all five conditions, IV placement frequency ranged from 1% (Seoul) to 80% (Nova Scotia), Oxygen administration rates ranged from 40.7% (Manchester) to 98.0% (Tokyo). Only New Haven, NSW, and Nova Scotia provided data on aspirin administration for chest pain, and frequency was 72.7%, 90.0%, and 40.0%, respectively. Nitroglycerin administration frequency for chest pain cases ranged from 0.0% (Osaka/Sapporo/Okinawa) to 90.0% (NSW). Nebulizer treatments for dyspnea ranged from 0.0% (Tokyo, Osaka/Sapporo/Okinawa) to 50.0% (New Haven). Epinephrine use in cardiac arrest ranged from 0.0% (Seoul) to 100% (Osaka). Taipei was not able to provide data for interventions. **Conclusion:** Prehospital intervals varied widely across study locations, as did the frequency of interventions for each condition. On-scene time accounted for the largest proportion of total prehospital time. This raises questions regarding differences in geography, operational policy, and scope of practice. Future research should examine the influence of these

differences on patient outcome and system efficiency.

65. TRENDS IN THE UTILIZATION OF EMERGENCY MEDICAL SERVICES (EMS) FOR THE CRITICALLY ILL PATIENTS

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Background: In recent years, the value of pre-hospital emergency care has increased due to its great impact on patient's survival and outcome. The Emergency medical services (EMS) play a crucial role in the life saving interventions for the critically ill patient. Despite this, we are still seeing critically ill patients brought to Emergency Departments by means other than by the ambulances. Our objective was to describe the prevalence of EMS use for the critically ill patients and identify patient groups that may be under-utilizing EMS use. **Methods:** Using the database of the main receiving hospital in the region from 2012–2013, a retrospective chart review was done reviewing all patients who were admitted through the emergency department to any intensive care unit. We reviewed their mode of arrival to the hospital and identified patient groups that had a significant difference in their mode of arrival based on their diagnosis and the specific intensive care unit that they were admitted in. We used 2×2 tables and chi-square tests and analysis to reach the reported results. **Results:** In this study, there were 450 critically ill patients admitted to one of the intensive care units through the emergency department and only 146 (32.4%) arrived by ambulance vs. 304 (67.6%) by private car. The groups that were identified to have a significant difference in their mode of arrival were: Cardiac care units admissions, 37 (8.4%) arrived by ambulance vs. 161 (36.5%) by private car, pediatric populations 3 (0.7%) arrived by ambulance vs. 50 (11.3%) by private car and trauma patients 64 (14.5%) arrived by ambulance vs. 23 (5.2%) by private car. **Conclusion:** In a representative sample of Intensive Care Units Admissions through emergency departments from 2012–2013 there was a significant under-utilization of the EMS use in general. This was more significant for Cardiac and pediatric patients. Efforts to improve access to care could focus on patient groups that benefit the most but still under-utilize the EMS system for such conditions.

66. HOSPITAL WIDE PEDIATRIC DISASTER SURGE DRILL USING MOULAGED CHILDREN: LESSONS LEARNED

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Background: Table-top exercises and moulaged adults are used to test pediatric surge response. We hypothesized that use of live children in a disaster drill is feasible. **Methods:** This was a descriptive analysis of a single level 1 inner city trauma center's experience using live moulaged children during participation in a citywide pediatric disaster surge drill. A mock disaster involving 500 pediatric patients was alerted to participating EDs, with our ED expecting to receive 100 pediatric victims. Code Triage was activated, initiating the Hospital Incident Command System, the hospital's emergency operations plan. Volunteer children and adults were staged with moulage makeup in a parking lot near the hospital and taken to the ED via ambulance. Volunteer victims were recycled back to the moulage station by ambulance in order to add more victim scenarios to the exercise. Adults not participating in the drill

chaperoned the children. In the ED the victims were triaged using paper cards with vital signs and injury descriptions and taken to their respective destinations. We assessed the feasibility of using live children in this disaster drill.

Results: Nine children ranging from 6–13 years of age and three adults volunteered for the drill. Two ambulances and four EMTs volunteered. Twenty-seven total victims were brought to the ED- 24 pediatric and three adults. Pediatric dispositions included: 3 OR, 11 PICU, 3 monitored pediatric bed, and 3 morgue. Two adults were transferred to the adult ED and one moulaged pregnant patient was brought to labor and delivery. Using children required immediate changes in the plan that we had not predicted. These changes included implementing photographs at triage for reunification and tracking, changing our in-hospital patient tracking system, and moving the child safe area. One child wandered off during the drill and was identified and retrieved quickly. Feedback from the multiple hospital departments and the volunteers was positive. **Summary:** Using live children in a pediatric disaster drill is feasible and allowed us to identify pediatric specific issues that would not have been identified in a table-top drill. We recommend use of security, chaperones, and identification photographs when using live children during drills.

67. SERIOUS PLAY: FEEDBACK TO IMPROVE A DISASTER TRIAGE VIDEO GAME

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Background: Video games are increasingly being used as an educational strategy for EMS. Usability and enjoyment are criteria for successful video games. This article describes the beta-testing of an EMS disaster triage web-based video game we developed. It is important to evaluate usability prior to deployment to a large number of learners; if a game is difficult to play, it is not appropriate to measure its efficacy as an educational intervention. **Objective:** We aimed to elicit learners' feedback to evaluate users' experience and guide the iterative development of the game. **Methods:** This prospective mixed methods study enrolled paramedics, emergency medical technicians (EMTs), EMS students, and undergraduate students. Participants played three levels of the game with multiple-casualty incidents (12 patients per level using the START/JumpSTART triage algorithm) and received automated electronic feedback after each level. After playing, participants completed a survey assessing gameplay realism, accessibility and engagement. One research assistant observed players, independently rated their interaction with the game, and documented technical difficulties. Five-point Likert scales anchored at Strongly Disagree and Strongly Agree were used for survey questions. **Results:** There were 22 players (6 paramedics, 4 EMTs, 7 EMS students, and 5 undergraduate students). Players' qualitative responses included suggestions about electronic feedback and comments on gameplay realism, accessibility, and engagement. Frequent suggestions were adding a practice level and improving concordance of player actions with visual gameplay. Across the three levels, 82% of players disagreed or strongly disagreed with the statement that the game levels were hard to navigate. Players agreed or strongly agreed (89%) that game levels were realistic and engaging. Regarding electronic feedback, 70% of players agreed or strongly agreed that it was accurate; they agreed or strongly agreed (81%) that it was clear; and they agreed or strongly agreed (81%) that it was helpful. **Conclusion:** Eliciting learners' feedback revealed several

ways to improve our game, including adding a game tutorial and amending graphic design. These items were immediately addressed and the game was updated prior to implementation.

68. BASIC LIFE SUPPORT ACCESS TO INJECTABLE EPINEPHRINE ACROSS THE UNITED STATES

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Background: The rising incidence of anaphylaxis, a life-threatening allergic reaction, has increased the need for treatment. Basic life support (BLS) EMS providers are frequently in a position to provide the first care to someone experiencing an anaphylactic reaction. Intramuscular injection of epinephrine is the definitive pharmacologic treatment for many associated symptoms. Although easy to use, epinephrine autoinjectors (EAI) are prohibitively expensive, having increased in price ten-fold in ten years. Some states and EMS departments have begun expanding the scope of practice to allow BLS providers to administer epinephrine by syringe. **Objectives:** An up-to-date, comprehensive list of how epinephrine is carried and used by EMS across the USA does not exist. This makes it difficult to assess the use of alternatives to EAI. **Methods:** An online survey focusing on anaphylaxis protocols and epinephrine administration was sent to 50 EMS Directors and Medical Directors. Follow up telephone calls were made to assure 100% compliance. Data is analyzed with descriptive statistics. **Results:** The 100% compliance was obtained: 49 of the 50 states in the USA provided a survey response. Texas, the only state that did not, was unable to respond due to the tremendous variation between EMS departments and sometime individual ambulances across their state. In each state, the form of epinephrine allowed or required on BLS ambulances was consistent with the scope of practice of their Basic EMT. Thirteen states have training programs to allow BLS providers to inject epinephrine; 7 are considering it; 30 are not. Twenty-seven states specifically rely on EAI on BLS ambulances if they chose to carry epinephrine and of these 14 require EAI. No states report allowing EMRs to use syringe injectable epinephrine. **Conclusion:** This study confirmed that many states have expanded the training of BLS providers to include the use of syringe injectable epinephrine. The majority of states continued to rely on EAI in BLS ambulances. The potential economic impact of switching to alternative forms of injectable epinephrine is huge.

69. A SYSTEMATIC REVIEW OF THE ASSOCIATION BETWEEN EMS RESPONSE TIME AND MORTALITY

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Background: Response time has been used as a measure of EMS system quality for many decades with the assumption that a faster response saves lives. **Purpose:** To conduct a comprehensive systematic review of the peer reviewed literature assessing the association between EMS response time and mortality. **Methods:** Medline, EMBASE, and CINAHL were searched up to January, 2015 for articles describing original data that explicitly associated ground ambulance operational response time (time from emergency call to vehicle arrival on-scene) and mortality at hospital discharge. Conference abstracts and non-English language ar-

ticles were removed. Two independent assessors reviewed the candidate titles, abstracts, and full text with discrepant reviews resolved by consensus. **Results:** A total of 10,151 articles were considered for title and abstract review, with 199 articles considered for full text review, and 49 articles meeting inclusion criteria. All articles were observational study designs reporting on the following patient populations: 38 (77.6%) cardiac arrest, 5 (10.2%) general EMS population, 4 (8.2%) trauma, 1 (2.0%) respiratory arrest, and 1 (2.0%) acute myocardial infarction/cardiac arrest. The publication years were: 17 (34.7%) 2010–15, 12 (24.5%) 2000–9, 11 (22.4%) 1990–9, 7 (14.3%) 1980–9, and 2 (4.1%) 1970–9. There were 14 (28.6%) studies where response time was the primary exposure of interest, with the remainder of included articles reporting response time as part of a descriptive multivariable model or secondary analysis. Of the 14 primary exposure studies, EMS systems varied, but included BLS, ALS, and combined systems. There were multiple approaches to assessing the association, including hypothesis testing between survivors and non-survivors and between response time dichotomous cut-points, and regression using response time as a measured variable and at dichotomous cut-points. Statistically significant findings of association in these studies included: cardiac arrest (5/7 studies), general EMS population (1/5 studies), and trauma (0/2 studies). **Conclusions:** There is a substantial body of literature describing the association between response time and mortality, but evidence informing this relationship is heterogeneous and complex. Important details such as patient population, EMS system characteristics, and analytical approach must be taken into consideration to appropriately translate these findings to practice. These results will be important for EMS leaders wishing to create evidence-based response time policies.

70. EVALUATING THE UTILITY OF THE STATUTORY REQUIREMENT OF BLS EPIPENS IN MICHIGAN

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Background: Legislation in Michigan requires all EMS-basic life support (BLS) vehicles to carry epinephrine auto-injectors (EAI) in adult and pediatric doses. While widely prescribed for patients with known anaphylaxis, the costs and utility of mandating BLS-EAI throughout a State is unknown. Our objective was to examine the temporal benefit of BLS-EAI use in Michigan and cost of equipping these vehicles. **Methods:** Using the Michigan EMS Information System (MI-EMSIS), we performed a retrospective review of all cases with primary or secondary impression of allergic reaction and who received any epinephrine during 2014. Data and case narratives were analyzed collecting demographic data, BLS and ALS response time, epinephrine delivery (drawn or auto-injector), who administered EAI (patient/bystander, BLS or paramedic), and source (patient, BLS, ALS). To assess the temporal benefit of BLS-EAI in different demographic regions, we abstracted location, including urbanicity (Southeast Michigan, includes half the State's population, [SE Michigan]), all Michigan metropolitan/micropolitan statistical areas (2000 census; [Metro]), and non-metro-micropolitan (Rural). To estimate the EMS system cost of equipping BLS ambulances with EAI, we performed a sensitivity analysis varying percentage of licensed vehicles stocked (50–100%) and cost of EAI two-pack (\$300–\$450). Descriptive statistics are presented. **Results:** During 2014, there were 1,550,009 EMS responses reported. Allergic reaction was the primary impression

in 5,994; 494 received epinephrine. The mean age was 42.8 years (range 1–97) with 50.3% male. EAI were administered 180 times by: patients/bystanders (n = 102); BLS (n = 45); ALS (n = 33). BLS-EAI before use varied by region type: Rural (n = 11); SE Michigan (n = 14); Metro (n = 34). Time to BLS and ALS arrival on scene varied by system (Median, 90thile, in min): Rural BLS (11,21), ALS (8, 17); SE Michigan BLS (4,9), ALS (6, 11); Metro BLS (6,11), ALS (6, 13). The cost to equip Rural systems with EAI ranged from \$22,950–\$68,850. This was less than the SE Michigan and Metro systems, which were \$79,500–\$238,500 and \$151,350–\$454,050, respectively. **Conclusion:** Required stocking of BLS units with EAI may have utility in rural portions of Michigan. For metropolitan areas it is costly and has limited value in decreasing time to epinephrine administration.

71. USE OF D50 VS D10 FOR TREATING HYPOGLYCEMIA: A REVIEW OF EMS PROTOCOLS IN THE UNITED STATES

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Background: Hypertonic dextrose (D50) administered as 25 g of glucose bolus in adults or 0.5–1 g/kg in has been used for the parenteral treatment of hypoglycemia in the prehospital setting for decades. Its use is problematic since it provides supraphysiologic levels of glucose, extravasation can cause tissue necrosis, and pediatric dilution calculations are error-prone. The titration of D10 to clinical response is an alternate treatment option that has been shown to be effective and safe and is used in EMS protocols in the United Kingdom and Singapore. **Objective:** To examine the current concentration and dose of parenteral hypertonic dextrose for the treatment of hypoglycemia in a sample of EMS protocols in the U.S. **Methods:** We reviewed EMS protocols from 2 sources: URL links on the website www.emsprotocols.org and from the 50 largest populated cities in the US. We used a structured data collection tool to abstract information from EMS protocols regarding the use of parenteral hypertonic dextrose, including the concentration of hypertonic dextrose and the initial dextrose dose. Descriptive statistics were used to summarize the findings. **Results:** Protocols were retrieved from 185 EMS agencies distributed across the U.S. Of these protocols, 130 (70%) specified only D50 for the treatment of hypoglycemia in adult patients, 15(8%) only D10, and 40 (22%) either D10 or D50. A majority of the protocols (65%) utilized D50 and specified dilutions to D25, D12.5, or D10 for children. For neonates, 67% of the protocols specified the use of D10 or D12.5. The most frequently specified initial dose of glucose was 25 g of glucose for adult (72%), 0.5 g/kg for pediatric (66%), and 0.5 g/kg for neonatal (47%) patients. **Conclusions:** The majority of EMS protocols for treatment of symptomatic prehospital hypoglycemia reviewed specified the use of D50 in adult patients and dilutions of this for children. Most protocols called for the administration of 25 g of dextrose in adults and 0.5 g/kg in children. Further studies are needed to determine the optimal treatment for hypoglycemia and to understand the reasons for the differences in U.S. EMS protocols and their effect on patient care.

72. CRITICAL CARE TRANSPORT OF ADVANCED CARDIAC AND PULMONARY ASSIST DEVICES: A SINGLE PROGRAM RETROSPECTIVE REVIEW

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Background: The number of critical care transports (CCT) will likely increase due to the regionalization of specialty medical centers and an aging population. Our CCT program uses a dual Prehospital Registered Nurse (PHRN) crew configuration. In addition, a perfusionist accompanies all ECMO transports. Our study aims to report a single center's experience with the critical care transport of patients supported by cardiac and pulmonary assist devices, including Extracorporeal Membrane Oxygenation (ECMO), intra-aortic balloon pump (IABP), Left Ventricular Assist Devices (LVAD), Impella ventricular assist devices, and temporary pacemakers (transvenous, transcutaneous, and epicardial). **Methods:** We performed a retrospective review of patients transferred by our critical care transport service while supported by ECMO, IABP, LVAD, Impella, or temporary pacemaker. All patients over 18 years of age who were transported between January 1st, 2012 and June 30th, 2015 were included in the study. Data were abstracted from prehospital and in-hospital medical records by two researchers concurrently. Any disagreements were resolved by discussion. **Results:** During the study period there were 134 cardiac and pulmonary assist devices transported (6 VV ECMO, 20 VA ECMO, 71 IABP, 15 LVAD, 3 Impella, 19 Temporary Pacemaker) during 123 critical care missions. Major adverse events occurred during 3 transports (2.4%), and minor adverse events occurred during 38 transports (30.1%) with no out-of-hospital deaths. Interventions by transport crew resulted in improvement in patient status in 38/41 (92.7%) adverse events, and no change to patient status in 3/41 (7.3%). Rotary-wing aircraft transported 78.4% of patients, while ground units transported 21.6%. The mean out-of-hospital time was 55.5 +/-29.8 minutes (mean +/-SD), and mean distance of transport was 40.0 +/-31.4 miles (mean +/-SD). **Conclusions:** Interfacility transport of cardiac and pulmonary assist devices can safely be accomplished by a dual PHRN crew configuration along with perfusionist support of ECMO transports. In our critical care transport program, out-of-hospital adverse events that occur during transport are appropriately managed by a crew of two PHRN providers.

73. TEMPORAL TRENDS IN CRITICAL CARE TRANSPORT

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Background: The delivery of critical care is a continually evolving practice. Changes in health care delivery across health systems have resulted in changes in hospital capabilities and patient care practices over time, particularly in the delivery of care at community vs. tertiary care sites. We aimed to describe trends in patient characteristics and medical care delivery during interfacility critical care transport of adult patients by a large multi-state air medical service. **Methods:** Data were obtained from the electronic medical records (emsCharts, Inc., Warrendale, PA) of STAT MedEvac from 2005 to 2014. Data included patient age, gender, medical category, vital signs, procedures performed, medications administered, referring location, receiving location, and transport distance. The relationship of vital signs and critical care interventions (ventilator use or administration of vasoactive medications, thrombolytics, paralytics, or blood products) over time were analyzed using linear regression, adjusting for patient age, gender, medical category, referring/receiving location, and transport distance. **Results:** We reviewed 58,166 adult (age ≥18 years) interfacility critical care transport records over the 10-year period. Mean (SD)

transport volume per year was 5,817 (+/-387). Over this period of time more patients had initial hypotension (SBP0.90 [OR 1.09, 95%CI 1.06-1.12]), and altered mental status (GCS100 [OR 1.02, 95%CI 0.99-1.04]) or hypoxia (SpO2 <90 [OR 1.04, 95%CI 0.98-1.10]). The incidence of any abnormal vital sign increased by approximately 5% per year (OR 1.05, 95%CI 1.03-1.08). Similarly, the need for mechanical ventilation (OR 1.05, 95%CI 1.02-1.07) and critical care infusions (vasoactive agents or blood products) (OR 1.14, 95%CI 1.11-1.16) increased year over year (combined critical care interventions OR 1.11, 95%CI 1.09-1.14). **Conclusion:** Among patients transported between hospitals by a regional critical care service, the incidence of patients with initial unstable vital signs increased over the last decade. Similarly, the need for critical care interventions including mechanical ventilation and critical care medications or blood products increased during the same time period. These observations may inform utilization, further protocol development and have implications for regionalization of care.

74. LISTENING TO CARE PARTNERS: A FEASIBLE METHOD TO SCREEN FOR FRAILTY IN EMERGENCY MEDICAL SERVICES?

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Background: Frailty is a state of vulnerability, and may go unrecognized in emergency medical services (EMS). Identifying frailty earlier may allow for services to be offered proactively to maintain function and prevent further health deterioration. The Clinical Frailty Scale (CFS) can be used to screen for frailty, but has only been validated when used by physicians. Our objective was to evaluate the feasibility and validity of a Care Partner-completed CFS, facilitated by a paramedic or nurse. **Methods:** A prospective sample of older adults (age ≥ 70 years) presenting in two settings (to EMS, following a 9-1-1 call, and to Geriatric Ambulatory Care) between February 2009 and March 2010 were included. Care partners completed a survey that included the nine-point CFS, which grades from 1 (very fit) to 9 (terminally ill). Demographic, clinical and outcome data were collected from the health care record, with one year follow-up. Based on clinical evaluations a frailty index was calculated for each patient. In each setting, descriptive statistics were used to compare fitter patients (CFS scores 4). **Results:** The mean age was 82.2 ± 5.9 years ($n = 198$) and most were women ($n = 118$, 62.1%). The Care Partner-CFS was incomplete for 3 surveys. The median CFS score in both the clinic and EMS groups was 5 (interquartile range = 4-6). The Care Partner-CFS correlated moderately with their independently assessed frailty index (0.64; $p = .4$). Frail patients were older and had worse health outcomes than the patients with score <5 . More EMS patients were severely frail or very severely frail compared to the geriatric clinic patients ($n = 19$, 19% vs. $n = 5$, 5%). **Conclusions:** The Care Partner-CFS is a feasible and valid method for evaluating frailty in the EMS and medical clinic settings where frailty was common. It may be a useful EMS screening tool to identify those that could benefit from comprehensive assessment and follow-up after emergency care. Future research will evaluate this approach in multiple populations with community based follow-up intervention for those at higher risk.

75. AMBULANCE CARE REPORT REVIEW: CLINICAL CHARACTERISTICS OF OLDER ADULT PATIENTS TRANSPORTED TO THE EMERGENCY DEPARTMENT BY AMBULANCE

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Background: Handoff communication between Emergency Medical Services (EMS) providers and the Emergency Department (ED) includes an ambulance care report (ACR), the written record of prehospital assessment and care. Inadequate communication can lead to lost information and medical errors, especially for older adults. Advances in technology allow ACRs to be incorporated into the electronic medical record (EMR), available both to the ED care team and to the subsequent inpatient hospital providers. Our goal was to assess differences in clinical outcomes between older adult patients with and without an ACR in their EMR. **Methods:** This retrospective study included patients age ≥ 65 years transported to a large, urban, academic ED by ambulance from 04/2011 to 03/2012. A random sample (13%) of the 6,320 visits meeting inclusion criteria was reviewed. Outcomes of interest included: Emergency Severity Index (ESI), ED length of stay, ED disposition, re-presentation to the ED, and mortality. Analyses were performed using Stata 12.0. Groups were compared using Chi-square tests, Student's t-tests, and Kruskal-Wallis tests. **Results:** Of the 850 records reviewed, 18% did not include an ACR. Most patients brought to the ED by ambulance were female (61%) and Caucasian (63%). 176 (21%) visits were for patients transported to the ED from a skilled nursing facility; these patients were on average several years older than community-dwelling counterparts (83 ± 9 vs. 80 ± 8 ; $P < 0.001$), more often had baseline diagnoses of dementia (52% vs. 13%; $P < 0.001$), and were more acutely ill (ESI level 1 or 2: 20% vs. 13%; $P = 0.003$). Patients with ACRs were more likely to be discharged home from the ED (28% vs. 16%) and less likely to be discharged to a skilled nursing facility (4% vs. 11%, both $P = 0.001$). **Conclusions:** Many of the EMRs were missing ACRs. Presence of an ACR in the EMR was significantly associated with discharge home from the ED, possibly because review of ACR content allowed for safe disposition home instead of a potentially unnecessary admission to the hospital. More research is needed to determine how patient-centered outcomes are affected by ACR content and provider access to ACRs during initial ED evaluation.

76. CAN PARAMEDICS DRAW UNCONTAMINATED BLOOD CULTURES PRIOR TO PREHOSPITAL ANTIBIOTIC ADMINISTRATION?

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Background: Early antibiotic administration in the presence of sepsis can significantly decrease morbidity and mortality. CMS core measures require blood culture collections prior to administration of antibiotics. If uncontaminated blood cultures could be obtained by EMS prior to ED arrival, this would considerably reduce time to antibiotic administration for patients with the potential diagnosis of sepsis. In order to facilitate meeting core measures, we determined the rate of contaminated prehospital Paramedic acquired blood cultures. This analysis is part of a larger "Sepsis Alert" prehospital protocol that calls for Paramedic administered antibiotics. **Methods:** Retrospective, case series from a 3rd service EMS system model in the Greenville, South Carolina metropolitan area between November 14, 2014 and April 30, 2015 of blood cultures drawn from all 9-1-1 call adult patients. "Sepsis Alert" criteria were created

using current Surviving Sepsis guidelines: 2 of 3 signs of systemic inflammatory response [HR, RR, oral temperature] and a known or suspected source of infection. Paramedics received 12 h of didactic and practical training that included aseptic technique and proper extremity blood culture collection. Contamination was defined by the receiving hospital laboratory analysis. Patient demographic data was gathered for descriptive statistical analysis. **Results:** During the 6-month pilot, 120 trained paramedics acquired 356 blood cultures from 379 patients (55.3% male and mean age 65) with a 94.10% (335/356) no contamination rate. Contamination was found in 5.89% (21/356) with 14/21 (66.7%) of these identified as skin flora (coagulase negative Staphylococci). Most common ED admitting diagnoses were Sepsis 202/356 (56.7%), Severe Sepsis 47/356 (13.2%), and Septic Shock 30/356 (8.4%). Primary infection source included 46% pulmonary, 24% GU, 16% unknown, 6% skin, 4% GI, 3% other, and 1% implanted device. **Conclusion:** This study demonstrates the potential for Paramedics to facilitate completing 1 component of the Core Measure Bundle for sepsis treatment in the field by acquiring prehospital blood cultures with a low contamination rate prior to antibiotic administration. It is yet to be determined if a 6% contamination rate is clinically acceptable and if these findings are stable.

77. HOW WELL DOES A PREHOSPITAL SEPSIS ASSESSMENT TOOL CORRELATE WITH ELEVATED SERUM LACTATE LEVELS: IS A PARAMEDIC'S ASSESSMENT ENOUGH?

Jason G. Walchok, Martin E. Lutz, Colt F. Shope, Douglas Furmanek, Ronald G. Pirrallo, Greta Gue', Aaron C. Dix, Greenville County EMS

Background: The prehospital treatment of the septic patient goes rarely beyond fluids and transport. If reliable early sepsis identification can be accomplished prior to ED arrival, this may reduce time to antibiotic administration. Point of care lactate monitoring can assist with sepsis identification though it has limited availability. What is unknown is how well a paramedic's clinical assessment, alone, correlates with an elevated serum lactate level and an admitting diagnosis of sepsis. **Methods:** This is a retrospective, case series from a 3rd service EMS system model in the Greenville, South Carolina metropolitan area between January 8, 2015 and April 30, 2015 of blood cultures drawn from all 9-1-1 call adult patients. An adult Prehospital Sepsis Assessment Tool was created using current Surviving Sepsis guidelines: 2 of 3 signs of systemic inflammatory response [HR, RR, oral temperature] and a known or suspected source of infection. A "Sepsis Alert" was called by paramedics and upon IV access a set of blood cultures and blood for lactate analysis was collected prior to field antibiotic administration. Blood collected by paramedics was analyzed in the hospital lab after ED arrival. The Sepsis Alert was compared to serum lactate levels and ICD 9 admitting diagnosis of Sepsis, Severe Sepsis or Septic Shock. Patient demographic data were gathered for descriptive statistical analysis. **Results:** During a 4-month pilot, Sepsis Alerts were called on 144 patients (Male 53%, mean age 67). The lactate level was greater than 4.0 mg/dl in 60% (86/144) and greater than 2.2 in 80% (116/144). The admitting diagnosis of Sepsis overall was 86% (124/144): Sepsis 56% (81/144) Severe Sepsis 12.5% (18/144), Septic Shock 17% (25/144). Non-Sepsis diagnoses included Viral 3% (4/144), COPD 1% (2/144); 1 case each of sinusitis, renal failure, seizure. Primary infection source included 40% pulmonary, 27% GU, 17% unknown, 7% skin, 4% GI, and 4% other. **Con-**

clusion: When a Paramedic calls a Sepsis Alert, their clinical assessment matches an ED sepsis diagnosis 86% of the time without knowing the lactate level. Appropriate early antibiotic administration in the prehospital setting may be possible using a Prehospital Sepsis Assessment Tool.

78. MEASUREMENT OF BLOOD LACTATE BY EMERGENCY MEDICAL SERVICES IN PATIENTS WHO MEET CRITERIA FOR SEPSIS IN THE PREHOSPITAL SETTING: A PILOT STUDY

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Background: Our objective was to pilot test the use of temporal artery thermometers (TATs) and handheld lactate meters by emergency medical services (EMS) providers to aid in the prehospital recognition of sepsis. **Methods:** We report on blood lactate measures in a non-consecutive case series of prehospital patients meeting established criteria for sepsis. Paramedics received education on systemic inflammatory response syndrome (SIRS) criteria, were trained in the use of TATs and handheld lactate meters, and enrolled patients who had evidence or suspicion of infection, met ≥ 2 SIRS criteria, and were being transported to participating hospitals. Blood lactate was measured in the prehospital setting and again in the emergency department (ED) via usual care. Paramedics entered data using an online database accessible at the point-of-care. **Results:** Prehospital lactate values obtained by paramedics ranged from 0.8 to 9.8 mmol/L, and a prehospital lactate ≥ 4.0 was documented in 13 of 112 enrolled patients (12%). The median interval between the paramedic assessment of blood lactate and the electronic posting of the ED-measured lactate value in the hospital record was 111 min. Overall, 91 patients (81%) were hospitalized after evaluation in the ED, 27 (24%) were ultimately diagnosed with sepsis, and 3 (3%) died during hospitalization. Subjects with prehospital lactate ≥ 4.0 mmol/L were somewhat more likely to have been admitted to the intensive care unit (23% vs. 15%) and to have been diagnosed with sepsis (38% vs. 22%) than those with prehospital lactate levels < 4.0 , but these differences were not statistically significant. **Conclusions:** In this pilot, EMS use of a combination of objective SIRS criteria, subjective assessment of infection, and blood lactate measurements did not achieve a level of diagnostic accuracy for severe sepsis or septic shock that would warrant hospital pre-notification and committed resources at a receiving hospital based on EMS assessment alone. Nevertheless, this work provides an early model for increasing EMS awareness and the implementation of novel devices that may enhance the prehospital assessment for sepsis. Additional translational research studies with larger numbers of patients and more robust methods are needed.

79. FIRST AID AND FIRST RESPONDER TREATMENT OF ASTHMATICS HAVING DIFFICULTY BREATHING WITH BRONCHODILATORS: A SYSTEMATIC REVIEW USING GRADE METHODOLOGY

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Background: Acute asthma attacks are a potentially life-threatening situation where timely treatment with bronchodilators may improve outcomes. In certain situations first

aiders/responders may be able to provide timely treatment and augment paramedic response. **Purpose:** Among adults and children in the prehospital setting who have asthma and difficulty in breathing (P), does bronchodilator administration by a first aider/responder (I), compared with no bronchodilator administration (C), change: time to resolution of symptoms, time to resumption of usual activity, complications, harm to patient, therapeutic endpoints (i.e., oxygenation and ventilation), and the need for advanced medical care (O)? **Methods:** This systematic review was conducted by the International Liaison Committee on Resuscitation (ILCOR) First Aid Task Force. Pubmed, EMBASE, and Cochrane databases were accessed up to February, 2014. Citations were independently reviewed by at least two reviewers for PICO criteria with discrepancy resolved by consensus. The GRADE approach was used to develop the question, prioritize outcomes, and appraise evidence. **Results:** There were 867 citations retrieved, with 8 randomized controlled trials (RCTs), 2 observational studies, and 1 meta-analysis included. No studies addressed first aid/responder situations and therefore quality was downgraded for indirectness, and some additionally downgraded for bias and/or imprecision. Differences in sample inclusion, medication, dose, and route prevented pooling of results. Studies included a variety of bronchodilators administered individually/in-combination, including albuterol/salbutamol, formoterol, salmeterol, isoproterenol, isoetharine, and ipratropium bromide. Routes included nebulization, dry-powdered inhaler, and metered-dose inhaler. These studies suggest bronchodilators were effective for reducing wheezing, dyspnea, and respiratory rate, while improving measures of effectiveness such as forced expiratory volume over 1 second and peak expiratory flow rate. There were few reported side effects, with one RCT reporting an increased heart rate of 9.2 beats per minute (95% CI, 3.51-14.93) in the group receiving one albuterol/salbutamol dose vs. the group receiving 1 dose q 30 min for 120 min. **Conclusions:** There was no evidence to directly assess bronchodilator administration by first aiders/responders. Low/very low quality evidence may suggest that the balance of benefit and risk favors intervention. First aid/response medical directors must carefully balance the value of providing this potentially effective intervention over the risk of adverse events in their individual setting.

80. VITAL SIGN CHANGES DURING EMS TRANSPORT

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Background: Current EMS teaching advises prehospital providers to obtain vital signs every five minutes for unstable patients and every 15 min for stable patients in order to accurately monitor changes in hemodynamics. No data currently exists in the literature to support the usage of these time intervals, or the need for repeat vitals at all. **Objective:** To determine whether repeat vital signs change significantly during EMS transport and if first vitals could accurately predict vitals later in transport. **Methods:** We performed a retrospective chart review of consecutive prehospital patient care records from July 2015 representing 6 ALS EMS agencies that contained at least two sets of recorded vital signs. We performed paired student's t-tests between the first and last blood pressures, heart rates, respiratory rates, and pulse oximetry to determine change over time. A univariate regression analysis was also performed to determine the association between

the first and last documented vitals. **Results:** A total of 310 charts were reviewed. Patients ranged in age from 18-86 and 163 (52.5%) were female. A total of 255 (82%) of the patients had a medical complaint, the remainder were traumatic mechanism of injury. First and last blood pressures (both systolic and diastolic) were statistically different ($p = 0.014$) but with an average difference of only 2 mmHg. Average differences between first and last heart rate (0.6 bpm, $p = 0.44$), respiratory rate (0.2 breaths/min, $p = 0.36$), and oxygen saturation (0.2%, $p = 0.51$) showed no statistically significant differences. Regression analysis of first and last systolic blood pressures showed a strong correlation with an R squared coefficient of 0.70. Regression of heart rate showed slightly less correlation with an R squared coefficient of 0.56. **Conclusion:** Little change was found between first and last vital sign measurements during prehospital transport and the clinical significance of these is questionable. Further work is necessary to determine the need for, and timing of, repeat vitals during prehospital transport.

81. PREHOSPITAL ADMINISTRATION OF KETAMINE FOR ADVANCED AIRWAY MANAGEMENT, EXCITED DELIRIUM SYNDROME, BEHAVIORAL EMERGENCIES, AND ANALGESIA IN A LARGE GROUND AND HELICOPTER BASED EMS SYSTEM: EFFECTIVE AND SAFE

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Background: Ketamine, a potent dissociative agent with profound analgesic properties, is well suited to prehospital care due to its numerous benefits compared to other agents. These include hemodynamic stability, maintenance of airway reflexes, and a wide therapeutic window. We implemented protocols for ketamine by intravenous, intraosseous, and intramuscular routes for a variety of indications. The rate of adverse events, including oxygen desaturation below 87%, laryngospasm, unplanned airway intervention, emergence reaction, allergic reaction, and death, was hypothesized to be less than 5%, respectively. **Methods:** We utilized a standardized method of chart review to analyze 2,008 separate patient encounters. Abstractors were trained and used a standardized form for data collection, with inter- and intra-rater reliability checks. Reliability was confirmed via test reports prior to case analysis. Periodic meetings were held throughout to monitor progress and clarify any issues. **Results:** We noted an exceptionally low rate of adverse events. Ketamine was used for: advanced airway management in 192 cases (9.6%); sedation following advanced airway management in 394 cases (19.6%); analgesia in 913 cases (45.4%); treatment of Excited Delirium Syndrome in 88 cases (4.4%); sedation in acute behavioral emergencies in 412 cases (20.5%); sedation during painful procedures in 10 cases (0.5%). The average dose was 126.2 mg. Additional ketamine was required in 92 cases (4.6%), with an average dose of 39.3 mg. Oxygen desaturation occurred in 43 cases (2.1%). There were no instances of laryngospasm. Unplanned airway intervention occurred in 36 cases (1.8%). There were 2 cases of emergence reaction (0.1%), and 3 cases of allergic reaction (0.15%). 32 cases (1.6%) involved a cardiac arrest during prehospital care; however, each of these patients was significantly ill or injured prior to ketamine administration and meaningful conclusions regarding the role of ketamine could not be drawn. **Conclusion:** Overall, the rate of adverse events was exceedingly low. There was significant effort to mitigate the inherent biases of retrospective chart review; however, two significant limitations remained: abstractors

were not blinded to outcomes or the research questions, and the quality of raw data was dependent on both the subjective assessment and chart completeness by the paramedics providing care.

82. IMPACT OF ADVANCED LIFE SUPPORT VS. BASIC LIFE SUPPORT PREHOSPITAL CARE FOR ASTHMATICS ON EMERGENCY DEPARTMENT LENGTH OF STAY AND ADMISSION RATES

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Background: Examine impact of ALS vs. BLS care for patients where emergency calls were for asthma/COPD exacerbations on ED length of stay (LOS) and rates of admission. **Methods:** Conducted a retrospective cohort study that examined the outcomes of University Hospital (UH) EMS responses to asthma/COPD exacerbations during a one-year period. Patients with respiratory emergencies were randomly assigned to either ALS or BLS transport based on availability of ALS units. Utilizing dispatch data/chart reviews, we identified 54 asthma/COPD patients that were transported to UH by BLS and 764 asthma/COPD patients transported by ALS. We matched patients transported by BLS to two ALS asthma/COPD patients based on their age within one year and also matched them based on gender, race, ethnicity, EMS response time, and type of respiratory disease. The ED charts of both BLS and ALS patients were blinded and reviewed for ED LOS times and admissions by an investigator with no knowledge of the patients' prehospital course. **Results:** For patients transported by BLS, the mean ED LOS was 5 h 13 min \pm 30 min (mean \pm SEM). For patients treated by ALS, the mean ED LOS was 6 h 27 min \pm 28 min (mean \pm SEM). A t-test comparing mean BLS to ALS ED LOS demonstrated significant difference between the two groups ($t = 2.06$, $df = 53$, $p \leq 0.04$). A total of 22.2% of the BLS patients vs. 34.3% of the ALS patients were admitted. This difference did not reach statistical significance ($p \leq 0.12$). **Conclusion:** It is generally thought that early administration of nebulizer treatments, steroids, and other medications by ALS can provide symptomatic relief and lead to better outcomes. When examining ED LOS-ALS patients had significantly longer ED LOS than BLS patients. Patients transported by ALS were admitted more frequently than those transported by BLS. Although the associated p-value was not significant, it approaches a trend. This may be explained by a bias that ED physicians/staff experience when seeing a patient arrive via ALS. These patients may be viewed as "sicker." This could result in ALS patients receiving more extensive workups than BLS patients. ALS patients receiving more nebulized albuterol treatments than BLS patients may explain this difference. If there is a concern of iatrogenic hypokalemia, laboratory testing may be requested and the time associated with obtaining and receiving blood labs may account for the ALS patients' longer LOS in the ED. Further study is needed to define the reason for better outcomes for patients transported by BLS for asthma and COPD exacerbations.

83. STEROIDS IN THE PREHOSPITAL MANAGEMENT OF ACUTE ASTHMA AND COPD EXACERBATIONS (SPAACE)

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Background: It is well established that the use of systemic corticosteroids in acute exacerbations of COPD (AECOPD) and asthma de-

crease treatment failures, improve FEV1, and shorten hospital length of stay in patients not requiring assisted ventilation. In our literature review, we did not find a single study that looked at the effect of EMS administration of corticosteroids on Emergency Department (ED) length of stay (LOS) or admission rates for AECOPD. We found only a single study looking at the effect on admission rates in adults with asthma exacerbation. We hypothesized that the use of prehospital corticosteroids in the treatment of acute asthma/AECOPD will decrease both the ED LOS as well as admission rates. This has the potential to greatly decrease associated hospital costs. **Objectives:** To determine if EMS administration of steroids in AECOPD/asthma will decrease admission rates and ED LOS. **Methods:** We conducted a prospective observational study of 644 consecutive patients, 18 years and older, presenting to our system's emergency departments from June 2013–December 2014 via EMS with a diagnosis of acute asthma/AECOPD. The institutional review board reviewed the study protocol and gave consent for the review of the medical records. Of the 644 patients, 207 patients were excluded due to confounding complaints or diagnosis that could change the LOS or disposition, leaving 437 patients included in the final analysis. **Results:** Overall 46% ($n = 201$) of patients were admitted (52 EMS group [54.74%] vs. 149 hospital group [41.81%]). The mean overall LOS for the study was 131 min ($n = 437$). Overall LOS favored EMS administered steroids but not to statistical significance (126.4, $n = 95$ vs. 132.57, $n = 342$ [$p = 0.37$]). LOS for discharged patients was longer in the EMS group (135.7, $n = 43$ vs. 121.4, $n = 193$ [$p = 0.11$]) but significantly favored the EMS group for admitted patients (118.7, $n = 52$ vs. 147.1, $n = 149$ [$p = 0.005$]). **Conclusion:** There was a non-statistically significant trend toward decreased ED LOS for EMS administration of steroids in asthma and COPD exacerbations. This trend was largely driven by the statistically significant decreased LOS for patients who were eventually admitted to the hospital.

84. SURVEYING THE OPINION OF PENNSYLVANIA CHIEFS OF POLICE TOWARDS OFFICERS CARRYING AND ADMINISTERING NALOXONE

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Background: Recent legislation in Pennsylvania has allowed law enforcement officers to administer naloxone (Narcan) to individuals in an opioid overdose, with the goal of saving lives by reviving victims before EMS crews arrive on scene. Governmental pressure has been subsequently placed on Chiefs of Police to put naloxone programs into place. Our goal was to survey Pennsylvania Chiefs of Police regarding their level of concern toward the potential obstacles to having officers use naloxone, and their overall opinion toward equipping officers with the medication. **Methods:** We created an anonymous survey that was administered to Chiefs of Police across Pennsylvania. Questions in the survey asked about their level of concern for four obstacles to police officer administration of naloxone: correct identification of situations in which to use naloxone, agitation of overdose patients after receiving the medication, cost of the medication, and the responsibility of departments to track each dose of the medication. A fifth question asked them the degree to which they agree that the benefits of equipping officers with naloxone outweigh the risks. All questions used a Likert scale from 1 (Not Concerned/Strongly Disagree) to 5 (Very Concerned/Strongly Agree). The survey was administered both in person at the Annual Conference for the Pennsylvania Chiefs of

Police Association (PCPA) and online over the PCPA listserv. **Results:** A total of 84 Chiefs of Police responded to the survey. The potential agitation of patients was their largest concern, with 60% responding either a 4 or a 5 (Very Concerned). The next largest concern was officers correctly identifying situations (42%), followed by the cost of the medicine (38%) and the administrative duties of the department (32%). Overall, 60% of Chiefs said that they "Strongly Agree" or "Agree" that the benefits of the policy outweigh the risks, while 23% indicated that they "Strongly Disagree" or "Disagree." **Conclusion:** The results indicate that although a significant subset show concern for the aforementioned obstacles, Chiefs of Police in Pennsylvania generally agree that the benefits of equipping officers with naloxone outweigh the risks.

85. POLICE ADMINISTRATION OF INTRANASAL NALOXONE: PROGRAM IMPLEMENTATION AND ONE-YEAR FOLLOW-UP

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Background: Opioid overdose rates continue to rise at an alarming rate; however, nearly all of these deaths may be prevented by the timely administration of naloxone. One of the methods used to combat this epidemic is the administration of naloxone by law enforcement. Many cities have implemented police naloxone administration programs, but there is a minimal amount of research examining this policy. The following study describes the implementation of a police naloxone program in Indianapolis, IN and examines data from a one-year follow-up on police officers use of naloxone. We describe the most common indications for police administration, patients' responses to the administration, and need for additional EMS intervention. This study also examines key law enforcement questions such as the requirement for arrest, immediate detention, or voluntary transport to the hospital. **Methods:** After initial training on opioid overdose recognition and naloxone administration, officers were equipped with intranasal naloxone kits. All police officer administrations were reviewed from April 2014 to June 2015 ($N = 95$). Data abstraction focused on the indication for administration, response to administration and subsequent requirement for immediate detention, arrest, or voluntary transport of the patient to the hospital. **Results:** Nearly all of the officers reported administering naloxone because the observed case was unconscious, cyanotic, and/or not breathing (98.9%). Of those administrations, most patients had a positive response of either returning to consciousness (60.0%) or spontaneously breathing (21.1%). Furthermore, the majority of patients were transported voluntarily to the hospital (83.2%), though some required involuntary detention ($n = 2$) or were arrested ($n = 12$). Lastly, there were no recorded untoward events (i.e., violence) in the police uses of naloxone. **Conclusion:** Administration of intranasal naloxone by police allows for early intervention that is both safe and effective, without an overwhelming amount of immediate detentions or arrests subsequently. As the distribution of naloxone to police officers begins to increase across the U.S., it is important to continue to investigate its impact on patients. Moving forward, further research is needed on whether the early administration of naloxone by police improves outcome when compared to EMS administration.

86. FIRST YEAR REPORT OF A STATEWIDE IMPLEMENTATION OF A COLLABORATIVE PROGRAM FOR LAW ENFORCEMENT NALOXONE

TO TREAT OPIOID OVERDOSE

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Background: Law enforcement officers (LEO) are on constant patrol in the community and have proven to be a valuable link in survival from cardiac arrest. They may serve a similar important role in opioid overdose. Intranasal (IN) naloxone administration is an accepted off-label treatment, removes hazard to personnel from sharps injury and is the safest way of adding opioid overdose treatment to the scope of practice for the LEO. We report the results of New York's statewide collaborative program to train and equip law enforcement officers to treat opioid overdose. The training program prepared LEO to administer IN naloxone in cases of suspected opioid overdose. These results demonstrate the results of the first 12 months of the statewide initiative. **Methods:** Law enforcement departments from across the state were encouraged to participate. There was no cost for participation. Training took approximately 1 h. Each utilization was followed up with completion of a Naloxone Quality Improvement Use Form. **Results:** Over 400 law enforcement departments and over 7,000 officers received the training in the first 12 mon. This project has resulted in over 474 overdose reversals by 137 different departments. Nearly 50% of the time LEO are on scene >5 min before EMS personnel, and in 30% this interval is >10 min. There was no actual hazard to personnel noted in case review. No adverse outcomes to patients were noted. **Conclusion:** This study demonstrates that a brief training program allows LEO to successfully participate in an opioid overdose treatment program. It also demonstrates the significant public health benefit because LEO are on the scene far in advance of EMS. As reversal of opioid overdose is a time sensitive intervention, lives are being saved. Given the significant public health and individual health benefits of being able to reverse an opioid overdose, and safety of the IN administration of the medication, this should pave the way for more wide-spread use of IN naloxone by appropriate trained law enforcement agencies.

87. VARIABILITY IN THE TREATMENT OF HYPOGLYCEMIA IN EMS PROTOCOLS IN THE UNITED STATES: IS THERE A STANDARD OF CARE?

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Background: In many industries, limiting variability has been linked to a reduction in errors. A minimal amount is known about the variability of treatment processes in the EMS industry. **Objectives:** To examine the variability for the treatment of hypoglycemia in a sample of EMS protocols in the U.S. **Methods:** We reviewed EMS protocols from 2 sources: URL links on the website www.emsprotocols.org and from the 50 largest populated cities in the U.S. We used a structured data collection tool to abstract information from EMS protocols regarding blood glucose treatment thresholds, glucagon use, IV or IO administration of hypertonic dextrose, post-treatment CBG or GCS follow-up, and the presence of a policy permitting non-transport of selected patients. Descriptive statistics, ANOVA and Kruskal-Wallis test were used to summarize the find-

ings. **Results:** Protocols were retrieved from 185 EMS agencies of varying sizes distributed across the U.S. The mean threshold level for adults was 65.9 mg/dl (SD 9.5 mg/dl, range 50–120 mg/dl) for adults, 62.9 mg/dl (SD 7.7 mg/dl, range 40–100 mg/dl) for pediatric patients, and 54.7 mg/dl (SD 10.8 mg/dl, range 30–80 mg/dl) for neonates, which are different ($p < 0.0001$). Both the median and mode blood glucose thresholds for the treatment of hypoglycemia was 60 mg/dl for patients of all ages. Almost all (97%) of the protocols reviewed allowed for the use of glucagon, if vascular access could not be rapidly obtained. Of the 185 protocols, 66% specified the administration of hypertonic dextrose IV or IO and 34% specified IV use only. Patient follow-up using CBG only was noted in 31% of the protocols, both CBG and GCS in 32% of the protocols, GCS only in 4% of the protocols, and follow-up was not specified in 33% of the protocols. A specific policy allowing for the non-transport of select patients whose hypoglycemia was corrected was noted in slightly more than half (52%) of the protocols. **Conclusion:** In the U.S., EMS protocols for the treatment of hypoglycemia vary. Further studies are required to determine the factors underlying this variability and the effects on patient outcomes.

88. EMERGENCY MEDICAL SERVICES (EMS) ASSIST-REQUIRING HYPOGLYCEMIA AND TYPE 1 DIABETES IN SOUTHWEST ONTARIO

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Background: Hypoglycemia is a common treatment consequence in diabetes mellitus (DM) and the second most common cause of Emergency Department (ED) visits for adverse drug events. Prior studies have examined the rates of ED visits and inpatient hospitalizations for hypoglycemia. These represent only a small proportion of severe hypoglycemic events, as many do not present to hospital. To date, there have been no Canadian population-based studies examining the rates of EMS assist-requiring hypoglycemia in DM patients in the prehospital setting. **Objectives:** To determine the prevalence and describe the EMS assist-requiring hypoglycemia in DM patients in Southwestern Ontario. **Methods:** A population-based retrospective cohort study was conducted on all EMS calls for diabetic emergency from 2008–14 in Southwestern Ontario, Canada. Data was extracted from the electronic ambulance call records for 11 EMS services in the region. **Results:** There were 9,265 EMS calls for a diabetic emergency (mean age 59 ± 20 years, 57% male, 82% DM). For 223 calls (2.4%) patients were younger than 19 years of age. The mean blood glucose level on presentation was 2.49 ± 1.02 mmol/L and 2,116 (24%) call subjects had initial GCS score less than 9. Treatment (intravenous glucose or IM glucagon) was given in 7,126 (77%) calls. There were 3,884 (51%) hypoglycemia episodes with documented insulin use and 1,436 (19%) documented oral hypoglycemia agents use. Between 2008 and 2014, rates of calls increased by 7.4% ($p < 0.0001$). Prevalence of hypoglycemia calls during the study period was estimated at 189 per 10,000 diabetes patients per year. In 2,297 (24.8%) instances, the patient refused transport to the ED. **Conclusion:** The rates of EMS assist-requiring hypoglycemia are almost double the rates of hospitalization/ED visits for acute DM complications in our region. Many life threatening episodes of hypoglycemia may go unreported and subsequently not followed by the patient's primary health care provider. Fur-

ther assessment and proper education following those episodes may help decrease the rate of severe hypoglycemia.

89. A NATIONAL DESCRIPTION OF KETAMINE USE IN THE PREHOSPITAL SETTING

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Background: Due to its powerful analgesic and sedative properties and low frequency of adverse effects, the use of ketamine in the prehospital setting has grown. There is no national estimate for the prevalence of ketamine use and its applications by paramedics in the U.S. **Objectives:** To describe the use of ketamine by nationally certified paramedics including protocols, indications, and perceived adverse events. **Methods:** A focused census survey of nationally certified paramedics was conducted electronically in July 2015. Only respondents who reported "patient care provider" as their primary role were included in these analyses. Military paramedics were excluded. Descriptive statistics were calculated. **Results:** Responses were received from 13,307 (20.6%) paramedics and 10,212 met inclusion criteria. About one-third (32.0%) of respondents reported that their protocols allow the use of ketamine, with 65.3% of protocols allowing use in adult and pediatric patients. Of those with protocols permitting ketamine use, about three-fourths (72.2%) were allowed to administer ketamine for rapid sequence induction (RSI), followed by chemical restraint or sedation (70.9%), pain management (55.1%), and procedural sedation (30.8%). The most commonly authorized route for ketamine administration was intravenous (94.1%), followed by intramuscular (65.0%). One-third (32.9%) of respondents reported never having administered ketamine, while 35.4% had given the drug five or more times. Most paramedics (96.1%) reported that ketamine successfully accomplished the necessary intervention and most (95.1%) said they would use the drug again. Few reported adverse events after administering ketamine (14.3%) and 8.3% said that an adverse event led to a negative patient outcome. Reported adverse events associated with ketamine use included emergence reactions (30.0%), respiratory depression (28.8%), excessive salivation (20.1%), myoclonic activity (9.9%), nausea with vomiting (9.9%), laryngospasm (7.0%), and nausea without vomiting (6.4%). **Conclusion:** This study serves as a baseline for the prevalence of ketamine administration in the prehospital setting by nationally certified paramedics. About one-third of paramedics were authorized by their protocols to administer ketamine in the prehospital setting. The most frequently permitted indications for ketamine administration in the prehospital setting were RSI and chemical restraint or sedation. Few paramedics reported adverse events associated with ketamine use.

90. EFFECT OF ON-LINE MEDICAL DIRECTION ON CONGESTIVE HEART FAILURE TREATMENT WITH FUROSEMIDE

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Background: When furosemide is available as a standing order protocol, paramedics have been shown to often inappropriately administer it to patients without congestive heart failure (CHF). Improved patient treatment may be realized by requiring furosemide admin-

istration to have a medical control order. **Objectives:** The purpose of this study was to examine the effect of requiring a medical control order on the frequency and appropriateness of furosemide administration. The study was conducted before and after a regional protocol requiring a medical control order was implemented. **Methods:** Patients treated with furosemide by Rural Metro Medical Services in Syracuse, New York, and transported to local hospitals over a 25-month period were identified by a retrospective review of prehospital medical records. Hospital records were reviewed to determine if EMS treatment with furosemide was: appropriate (CHF was diagnosed), inappropriate (no CHF diagnosed, and there was no diagnosis of pneumonia or sepsis and no IVF above KVO given), or potentially harmful (diagnosed with pneumonia or sepsis without CHF or treated with IVF above KVO). **Results:** A total of 67 cases were included for study. Furosemide was given 58 times when available as a standing order and only 9 times when a medical control order was required. During the standing order period, furosemide use was appropriate in 67% (39) of cases, inappropriate in 17% (10) of cases, and was potentially harmful in 15% (9) of cases. When given with a medical control order, furosemide use was appropriate in 56% (5) of cases, inappropriate in 11% (1) of cases, and was potentially harmful in 33% (3) of cases. **Conclusion:** Moving furosemide from a standing order to requiring a medical control order greatly decreased paramedics' use in prehospital CHF treatment, either from increased focus on nitrates and respiratory support or from the barrier of an extra step required for use. The change, however, did not help improve patient care. Requiring a medical control order actually decreased the percent of cases when furosemide was appropriately used and increased the percentage of use when potentially harmful in our small sample group.

91. WHAT IS THE CURRENT PERCEPTION OF THE CULTURE OF SAFETY IN A GROUP OF PARAMEDIC SERVICES IN ONTARIO?

Philip Moran, James Harris, Yuval Bitan, *Central East Prehospital Care Program*

Background: Patient safety culture represents the environment perceived by paramedics regarding safety, both for self and the patient, in the work environment. There are multiple factors involved in this, and a number of domains have previously been created and validated in prehospital care by Dr. P. Daniel Patterson. These include Safety, Teamwork, Stress Recognition, Perceptions of Management, Working conditions, and Job Satisfaction. **Objectives:** The purpose of this study was to determine the current perception of the culture of safety in EMS in the 6 agencies within our base hospital program. **Methods:** A questionnaire with 43 questions covering the 6 domains previously mentioned and one additional domain (Equipment Design) was administered anonymously to all paramedics in an Ontario Prehospital Care Program between September and December of 2014. All questions were scored using a Likert scale of 1–5. A positive score was determined to be a 4 or 5 on the scale. Scores were tallied for all paramedics and then for each of the six services separately, given that the management of each was independent, and two of the services were much larger and would skew the data for the smaller services. **Results:** A total of 904 surveys were completed out of 1,224 paramedics. For Safety Climate, there were 12% positive responses. Teamwork Climate had 9% positive responses. Stress Recognition was 47%. Perceptions of Management was 33%. Working Condi-

tions was 17%. Job Satisfaction was 58%. Equipment Design was 2%. **Conclusion:** The overall perception of the culture of safety among the paramedics in the Prehospital Care Program studied is poor. Individual areas must be identified within each domain and targeted for improvement so that the safety of both patients and paramedics can improve.

92. SLEEP-WAKE PATTERNS OF AIR-MEDICAL CLINICIANS: A PROSPECTIVE COHORT STUDY

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Background: Air-medical clinicians are shift workers and therefore at risk of poor sleep health, fatigue, and fatigue-related safety outcomes. **Objectives:** We sought to explore the relationships between sleep-wake patterns, shift work, and alertness among air-medical clinicians. **Methods:** We designed a multi-site, prospective cohort study of air-medical clinicians employed at 3 air-medical systems located in 3 of 4 U.S. Census regions (South, Northeast, and Midwest). Goal enrollment was set at 158 beginning May 2015. Eligibility criteria include: 1) age >18 years; 2) work clinically as a prehospital clinician; and 3) work 12 or 24-hour shifts. Clinicians completed reliable and valid measures of sleep health at baseline, a daily shift and sleep diary for 14-days, rated daily sleep quality and recovery between shifts, wore a wrist actigraph for objective sleep/wake measurement, and completed computerized psychomotor vigilance tests (PVTs) at the start and end of a minimum of 1-shift (max 5-shifts). We report preliminary findings on 19 participants. **Results:** Baseline sleep quality measured by the Pittsburgh Sleep Quality Index (PSQI) was poor for 63% of participants (Mean PSQI = 6.5, SD 2.5). Daytime sleepiness measured by the Epworth Sleepiness Scale (ESS) was "situational" or "excessive" for 10% of participants (Mean ESS = 6.7, SD 3.1). Fifty-two percent of participants were classified as fatigued at baseline based on the Chalder Fatigue Questionnaire. During the 14-day study period, the mean number of shifts per participant was 6.5 (SD 2.4) and mean shift duration was 15.2-h (SD 5.3). Mean number of hours off between shifts was 31.2-h (SD 27.8) and mean self-rated inter-shift recovery was 3.8 (SD 1.1; where 0 = Not Recovered At All, and 5 = Fully Recovered Mentally & Physically). Mean hours of sleep during the study period was 6.5-h (SD 1.4). Mean self-reported hours of sleep in the 24-h before a shift was 7.1 (SD 1.2) and 6.8 (SD 1.3) in the 24-h after a shift. **Conclusion:** Future work will examine the relationships between sleep-wake patterns, shift work patterns, shift duration, and alertness at the start and end of shifts. Findings will inform the design of fatigue risk management programs for air-medical clinicians.

93. ACCURACY OF LINKING EMS RECORDS TO THE EMERGENCY DEPARTMENT USING SOCIAL SECURITY NUMBERS

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Background: Patient Care Reports from EMS provide useful information to emergency department providers including initial presentation, EMS treatments, as well as condition of the home environment. As EMS agencies switch from paper patient care records to electronic patient care reports (ePCR), new strate-

gies will be needed to ensure that this clinical data is available to providers in a timely fashion, specifically automated algorithms to match ePCRs to emergency department records. Incorrect matches, both false positive and false negatives, can potentially negatively impact patient care. One proposal is using a patient's social security number (SSN) to match patient records. **Objectives:** To determine if SSN alone can be used to match EMS records with emergency department records. **Methods:** This was a retrospective cohort study of all consecutive patients brought in by a single EMS agency to the emergency department from 4/18/2015 to 6/14/2015. The study took place at an academic level 1 trauma center with annual ED volume of 57,000. We evaluated the performance characteristics of linking ePCRs to ED records using a patient's SSN alone. A single reviewer obtained a gold standard match by manually matching all patients' ePCRs to their emergency department record. A second reviewer then independently reviewed 471 patients (43.8%) to provide an agreement statistic. Descriptive statistics with confidence intervals as well as a kappa agreement statistic were calculated using JMP Pro 11. **Results:** A total of 1076 ePCRs were submitted by EMS, of which 805 had a SSN recorded. The kappa agreement statistic between the primary and secondary reviewer was 1. Compared to the gold standard, record linkage using social security alone had a sensitivity of 68% (65.1%–70.8%), specificity = 99.9% (99.9%–100.0%) PPV = 99.9% (99.2%–100%) and NPV = 97.8% (97.5%–98%). One false positive linkage occurred when a spouse's SSN was incorrectly entered for the patient. **Conclusion:** Although the record linkage algorithm using SSN alone is very specific, but not very sensitive. Further studies should be conducted to utilize additional identifiers to recover patients whose records cannot be matched by SSN alone.

94. DOES A FOCUSED EDUCATION PACKAGE IMPROVE PARAMEDIC COMPLIANCE WITH REFUSAL OF SERVICE DOCUMENTATION?

Philip Moran, James Harris, *Central East Prehospital Care Program*

Background: Refusal of service in prehospital care can sometimes result in a negative outcome for patients. Proper documentation of the refusal is essential, both as a guide for paramedics in obtaining proper informed consent and for medico-legal purposes. In Ontario, documentation of a refusal must include: (1) completion of a capacity assessment, (2) signature of the patient/ designated decision maker, (3) witness to the signature, and (4) signatures of both attending paramedics. Dates and locations must also be documented. Compliance with completion is historically poor. **Objectives:** The purpose of the study was to determine if a focused education package delivered to all paramedics in a Prehospital Care Program in Ontario would improve completion rates of the documentation for refusal of service calls. **Methods:** All refusal-of-service calls in the six paramedic programs within our base hospital program during the month of February, 2014 were reviewed and screened by 2 separate reviewers for completion of all of the required datasets on the ambulance call reports. Any disagreement was reviewed by a third assessor. Any missing data was considered an incomplete documentation. The education package was delivered during CME to all services in March 2014. In July, 2014, all refusal calls were reviewed again and the proper completion rate was compared to that in February. A chi-squared analysis of the results was performed to determine significance. **Results:** There were 112 properly completed refusals in

the first phase and 198 were incomplete (63.9% incomplete) and in the second phase there were 252 properly completed refusals and 160 were incomplete (38.8% incomplete). The difference was statistically significant ($p < 0.05$). **Conclusion:** A single education package significantly improved completion rates of the refusal of service sections of ambulance call reports. A repeat analysis will be performed in July 2015 to assess whether this rate persists with time. The completion of the documentation is recognized to be a surrogate for the proper explanation of the consequences of a refusal of service and there could still be an improper explanation of these consequences.

95. FACTORS PREDICTING MORBIDITY AND MORTALITY ASSOCIATED WITH PREHOSPITAL "LIFT ASSIST" CALLS

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Background: When an individual requires assistance with mobilization, emergency medical services (EMS) may be called. If treatment is not administered and the patient is not transported to hospital, it is referred to as a "Lift Assist" (LA) call. We have previously shown that LA calls are associated with morbidity and mortality. What places patients at an increased risk for morbidity and mortality is not yet known. **Objectives:** To determine factors that are associated with increased risk of 14-day morbidity, determined by an ED visit or hospital admission, and mortality in LA calls. **Methods:** All LA calls from a single EMS agency were collected over a one-year period (Jan-Dec 2013). These calls were linked with hospital records to determine if LA patients had a subsequent visit to the emergency department (ED), admission, or death within 14 days. Logistic regression analyses were run to predict ED visit or hospital admission within 14 days of the LA call from patients' age, gender, co-morbidities and vital signs at the initial LA call. **Results:** Of 42,055 EMS calls, 808 (1.9%) were LA calls. There were 169 (20.9%) ED visits, 93 (11.5%) hospital admissions, and 9 (1.1%) deaths within 14 days of a LA. Patient age > 61 ($p = 0.001$) and an Ambulance Call Record (ACR) missing at least 1 vital sign ($p = 0.017$) significantly predicted hospital admission. There was a 10% increase in risk of ED visit and hospital admission for every 10 year increase of age after the age of 61. Of the 96 patients with at least 1 missing vital sign, 14 (14.5%) were coded as patient refusals. The sample size was too small to determine predictors for mortality. **Conclusions:** Patients at risk for morbidity are older than 61 years of age and have co-existing cardiac disease. Patients who are greater than 61 years of age and had at least one missing vital sign on the ACR were more at risk for hospital admission.

96. HUMAN FACTORS EVALUATION OF A NEW AMBULANCE PATIENT COMPARTMENT

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Background: Ensuring paramedic safety while facilitating access to patients and equipment is a fundamental design challenge. Few observational studies have described the interaction among paramedics, patients, and compartment design during basic and advanced life support care. **Objective:** Describe paramedic behavior and interactions in a newly designed ambulance patient compartment during standardized patient scenarios. The study setting is a

provincial EMS system serving a population of 4 million people in a 660,000 sq/km area, responding to 400,000 calls per year, using 400 ambulances. **Methods:** The patient compartment was equipped with portable audio and video equipment to record paramedics treating a simulated patient. The patient progressed through an anaphylactic scenario, which required basic and advanced life support care from all participants. When transport was required, the ambulance was driven on a closed track following a standardized route. Patterns of interaction among providers, patients and equipment were analyzed using Noldus Observer XT (v.11.5) and SPSS (v.19). In addition, an online survey and structured post scenario debriefing were completed to elicit paramedic perceptions of the ambulance design. **Results:** A total of 101 paramedics participated in 47 scenarios, which lasted, on average, 28 min. A behavioral taxonomy was developed and applied to specific paramedic activities resulting in 9,810 coded interactions. During transport, paramedics were seated 65% of the time and used seatbelts for 3% of the time. Paramedics stood with less than three points of contact for 28% of the time while in motion. Providers were observed climbing over cabling or tubing 184 times and were entangled 23 times. Paramedics seated in the primary attendant chair and CPR chair used designed workspaces during 24% and 35% of the scenario respectively; otherwise workspaces were improvised including on the patient. Survey responses ($N = 544$) indicated that 28% of respondents agreed that the new ambulance design was better than previous designs, while 60% disagreed. **Conclusion:** Systematic observations of provider, patient and compartment interactions indicate a number of trade-offs between care delivery (equipment and patient access) and provider safety (seated, restrained, and facing forward). Evidence-based ambulance design recommendations were developed that sought to balance provider safety and care delivery.

97. LEAVING EMS: A LONGITUDINAL ASSESSMENT

Melissa A. Bentley, Remle P. Crowe, Roger Levine, National Registry of EMTs

Background: While the number of EMS providers leaving the profession has been previously quantified, no known national longitudinal estimates exist examining career attrition and factors associated with exiting the profession. **Objectives:** 1) Quantify the number of EMS providers that left the profession and 2) Describe important factors related to leaving the profession. **Methods:** Data were obtained from the second Longitudinal EMTs Attributes and Demographics Study. Newly nationally certified EMTs and paramedics were recruited in 2013 to participate in this 10 year study. The annually-administered questionnaire contained previously validated work-life characteristics, demographics, items related to leaving EMS, and likelihood of returning to the profession. Descriptive statistics were calculated. **Results:** In 2013, 2,615 EMTs and paramedics were recruited into the longitudinal study with 98.6% responding in 2013, 48.5% in 2014, and 41.0% in 2015. Between 2013 and 2015, 159 (11.3%; 88 in 2014 and 71 in 2015) EMS providers left the profession and 16 (1.1%) left and subsequently returned. These attrition rates are lower than those of other professions including nursing (19%), police (28%), and correctional officers (45%). Of those who left EMS, 44.8% worked for private services, 23.0% for fire departments, 18.4% for other service types, and 13.8% for hospitals. With respect to factors for leaving the profession, number of hours

worked was the most important (58.1%), followed by the desire to pursue further education (57.7%), desire for better pay and benefits (57.7%), lack of advancement opportunities (53.5%), dissatisfaction with organization management (51.2%), desire for career change (41.0%), lack of flexible schedule (39.5%), illness, injury or disability (39.5%), and moving to new location (35.7%). Of individuals who reported illness, injury or disability an important factor for leaving, seven (20.5%) reported that their illness, injury or disability was a result of their EMS job. Lastly, 51.7% of individuals who left the profession stated that they would definitely or probably return to EMS in the future. **Conclusions:** This study found EMS attrition is low compared to other professions. However, attrition was only assessed over a two year time period. Future efforts should continue to quantify attrition in EMS and identify factors associated with leaving.

98. STRESS AND SAFETY IN EMS: HOW WORK-RELATED STRESSES AND FATIGUE RELATE TO SAFETY OUTCOMES

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Background: Extant research has linked fatigue to safety-related outcomes in EMS personnel. Specifically, fatigue has been tied to an increased risk of paramedic injury, behaviors that may compromise patient and provider safety, and medical errors. However, a minimal amount is known about how other types of workplace stress, including organizational stress (the stress of working in a particular organization) and operational stress (stress associated with the provision of EMS services), critical incident stress (stress associated with patient care), and post-traumatic stress may influence patient and provider safety. **Objectives:** The purpose of this study was to assess the influence of these workplace stressors on safety outcomes. **Methods:** An online survey was conducted with eight EMS services with a 41% response rate ($n = 664$). Respondents reported levels of operational and organizational chronic stress, critical incident stress, post-traumatic stress symptomatology (PTSS), fatigue, safety outcomes, and demographic characteristics. T-tests and chi-square analyses were used to assess for significant differences. **Results:** In this sample, 75% of paramedics reported being injured, 95% reported safety compromising behaviors, and 72% reported making medical errors in the past three months. Paramedic injury and safety compromising behaviors were significantly related to operational stress ($p < 0.01$), organizational stress ($p < 0.01$), critical incident stress ($p < 0.01$), and post-traumatic stress ($p < 0.01$). In contrast, most of the stress variables (organizational stress, operational stress, critical incident stress, and PTSS) were significantly related to medical errors. The odds of reported injury among fatigued paramedics was significantly higher (OR = 2.8, 95% CI 1.9, 4.3), as were safety compromising behaviors (OR 5.3, 95% CI 2.1, 13.2), and medical errors (OR 1.5, 95% CI 1.1, 2.2). Few significant differences were noted in safety outcomes by demographics (years in EMS, level of certification, gender). The only noted difference was respondents with ≥ 10 years in EMS reported making fewer errors (OR 0.6, 95% CI 0.4, 0.9). **Conclusion:** These findings indicate that fatigue, chronic stressors, critical incident stressors, and post-traumatic stress might influence patient and provider safety. More investigation is needed to clearly elucidate the relative contributions of each type of stress on safety outcomes.

99. NEUROCOGNITIVE ENHANCEMENT SUBSTANCES USE IN EMERGENCY MEDICAL SERVICES PERSONNEL

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Background: Neurocognitive enhancement substances (NCES), notably caffeine and other mild stimulants, are ubiquitous in modern life. Shift workers use these substances to mitigate disruption of their circadian rhythms. NCES use has been studied in a number of professions—nurses, medical students, medical residents, college students, dance club revelers, locomotive conductors (and their spouses), but not, as yet, emergency medical service (EMS) providers. **Objectives:** As more interest develops about the health effects of these substances, we sought to define the use and perceptions in our EMS community. **Methods:** Anonymous 16-question NCES surveys were distributed to a convenience sample of EMS personnel during community and agency meetings and after patient delivery. The survey queried consumption of and personal beliefs regarding NCES. **Results:** A thousand surveys were distributed with 716 surveys returned (71.6% responses) from 19 distinct federal and civilian EMS agencies. Respondents were predominantly male ($N = 617$; 86%) and the average age was 35 years (range 18–68 years). We found use is high: 69% reported daily use, 63% used marketed “Energy Drinks,” 31% used coffee/tea, and 8% took prescription medications. Very few substances were used alone; 72% took several NCES in combination. The most cited reasons for NCES use was staying awake and to increase energy for recreational activities. Although 61% believe their job performance benefited, 74% did not believe these products were required for satisfactory job performance. A total of 57% believed NCES had minimal to no risk to their health, although 52% reported side effects overall, 17% stopped taking NCES because of side effects, and 3% had sought medical attention for side effects. This was a convenience sample that may affect obtained results. **Conclusion:** NCES use has a high prevalence in the EMS community. Three-quarters of our surveyed population consume some sort of caffeinated product on a daily basis and almost 10% used alternate substances. Two-thirds consider the risk to their long-term health low, and while over half report side effects, few providers have quit. Further study is needed to identify culture of NCES use, circadian sleep, and performance with the ultimate objective of making this important and dangerous job a little safer.

100. PREHOSPITAL CLINICAL PERFORMANCE MEASURES: AN ANALYSIS OF A NATIONAL COMMERCIAL EMR DATASET

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Background: Performance in EMS has traditionally been defined in terms of response times. Clinical benchmarks have been suggested but have not been well-defined, nor has any baseline data been presented. Working with a large, national electronic patient care record (ePCR) vendor (ESO Solutions), we suggest definitions for these measures and provide data to provide a starting place for comparison and improvement. **Methods:** We pulled data from calls by consenting agencies between 8/1/2010 and 7/31/2015. We looked at only 9-1-1 responses for all measures and excluded BLS agencies where appropriate. Our definitions were as follows: 1) Time to First Defibrillation: Dispatch to first defibrillation times for

all arrests with an initial shockable rhythm, 2) Patients over 34 with non-traumatic chest pain who received both a 12 lead and aspirin, 3) Patients with status epilepticus receiving benzodiazepine, and 4) Asthmatics with either a respiratory rate > 30 or an SaO_2 200 and either a respiratory rate > 30 or $\text{SaO}_2 < 90$ who received CPAP. **Results:** Data was analyzed from 609 agencies in 37 states serving over 22 million patients with over 2 million annual calls. The average time to first shock was 11.6 min for 5,430 patients (90th percentile 19.4 min, 13.7% < 5 min). A total of 40.2% of 292,113 chest pain patients received aspirin and an ECG. A total of 56% of 4,967 seizing patients received a benzodiazepine. 74% of 10,234 asthma patients received a beta agonist. The average scene time for trauma patients was 17.6 min (90th percentile 29.0 min, 15.6% < 10 min) for 7,007 patients. 57.2% of 1,446 CHF patients received CPAP. **Conclusion:** We provide a baseline from a large dataset for comparison when benchmarking clinical performance measures. There are several limitations. There were no charts reviewed and thus no context for this data. There are many agencies represented and it is likely there were varying data definitions used. Additionally, it was not possible for technical reasons to exclude patients with allergies to the studied medications, nor did we exclude trauma patients needing extrication.

101. PREHOSPITAL PROVIDERS' UTILIZATION OF ONLINE MEDICAL EDUCATION RESOURCES AND SOCIAL MEDIA

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Background: Free online medical education has become increasingly available over the past decade, predominantly among emergency medicine and critical care physicians. Many of these online resources are based through social media platforms and easily accessible to Emergency Medical Services (EMS) providers. **Objectives:** We sought to measure EMS providers' current utilization of online medical education and social media, as well as their interest in use of these resources for continuing medical education. **Methods:** A 13-question paper survey was distributed to EMS providers at a regional state EMS educational conference in Pennsylvania. Survey questions included demographic information, types of social media accounts used, sources of continuing education, and use of free online medical education. Data are reported using descriptive statistics. **Results:** Of 435 surveys distributed, 431 (99.1%) were returned, and 403 (92.6%) had complete data and were completed by EMS providers. The mean age of respondents was 42 years ± 12.4 . Respondents included Emergency Medical Responders (6.7%), Emergency Medical Technicians (EMT) (43.4%), Advanced EMTs (1.2%), Paramedics (38.5%), Prehospital Registered Nurses (9.2%), Prehospital Mid-level Providers (0.2%), and Prehospital Physicians (0.7%). Career length of respondents was > 20 years (40.9%), 10–20 years (25.3%), 5–10 years (16.1%), and < 5 years (17.4%). The majority of respondents (83.4%, 95%CI 79.7%–87.0%) maintain a social media account, most commonly Facebook (79.4%, 95%CI 75.4%–83.4%) and Twitter (25.8%, 95%CI 21.5%–30.1%). The majority of EMS providers (86.8%, 95%CI 83.5%–90.1%) use some form of online medical education, while less use textbooks (44.9%, 95%CI 40.0%–49.8%) or the combination of EMS magazines and peer-reviewed journals (50.3%, 95%CI 45.5%–55.3%). The most common source of online medical education is a state-based Learning Management System (60.8%, 95%CI 56.0%–65.6%), while 20.3%

(95%CI 16.4%–24.3%) of online learners use social media for medical education. Of the 13.2% (95%CI 10.0%–16.8%) of providers that do not utilize online resources, 81.1% (95%CI 68.0%–90.6%) have an interest in using online medical educational resources. **Conclusions:** Online medical educational resources are an important source of EMS providers' medical education. A majority of EMS providers maintain social media accounts, which represents a mechanism for expanding the delivery of online medical education to EMS providers.

102. EMERGENCY MEDICAL TECHNICIAN TRAINING FOR MEDICAL STUDENTS: A TWO-YEAR EXPERIENCE

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Background: New medical school educational curriculum encourages early clinical experiences along with biomedical integration. To promote clinical skills early in the curriculum, emergency medical technician (EMT) training was included in our medical school and begins in the first semester. Following course completion, the requirement exists to maintain the certification throughout the first 2 years with a required ambulance experience each month after training is complete. Along with the early clinical exposure, the program introduces interprofessional health and teams and provides the opportunity for students to personally see and appreciate the wide variety of environments from which their future patients emanate. **Objectives:** This report describes the EMT program and changes that were implemented after the first class to integrate the EMT course with the biomedical sciences. The value of this integration was assessed using subjective and objective criteria. **Methods:** A 2-year retrospective study was conducted that involved the first two classes of medical students using 2 outcome measures: student reflections and National Registry of EMT examination pass rates. **Results:** There were 53 students in the first class and 54 in the second. Of the all reflections submitted by students during the year, 60 out of 208 in the first class and 82 out of 216 in the second class related to an EMT experience. Of the students in the first class completing the state psychomotor and written examination, 20 in the first class and 17 in the second passed on the initial psychomotor skill attempt; however, more students passed in the first 3 attempts in the second class than the first class, 51 vs. 45, respectively. All students passed by 5 attempts. For the written examination, 50 students in the first class and 51 in the second class passed on the first attempt. All students passed by the third attempt. **Conclusion:** Results between the 2 classes demonstrated value in student perception but objective criteria used to evaluate the effectiveness of an integrated course was not significantly different.

103. EXAMINING THE ROLE OF EXPERIENCE AND AFFECTIVE PERSONALITY TRAITS IN PARAMEDIC STUDENTS' SUCCESS

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Background: Paramedic programs are evaluated on course completion rates and National Registry of EMT's pass rates by accrediting bodies and regulatory agencies. Like other health professions, EMS educators are interested in methods that predict student success as entrance exams and background evaluations. The connection between affective personality traits and paramedic success has also

been of recent interest to EMS educators. Many paramedic programs require varying levels of EMT experience for admission, because experience is believed to offer enhanced understanding. Although these predictive variables have been discussed, limited research on this subject has been completed. **Methods:** Scores on a validated summative EMS exam (PRE) were compared to sub-scores on a validated entrance exam (EE) and self-reported prior EMT experience. The EE consists of four content areas: Math, Reading, Anatomy/Physiology, and EMT Basics; and three non-cognitive sections: Agreeableness, Conscientiousness, and Neuroticism. Scores for the PRE and the EE were converted from total scores to logit scores, and the data was fit into a series of linear regression models. **Results:** The total number of students who completed both the EE and PRE was 291. The average PRE score was 74% (range 47–89%). The corresponding average logit score was 1.02 (range –0.10–2.09). The coefficients from the model suggest that four variables explain the differences in PRE logit scores with statistical significance. These factors were: 1) Experience of 2–5 years; 2) EE Anatomy/Physiology scores; 3) EE EMT Basic scores; and 4) EE Conscientiousness scores. Examinees with 2–5 years of experience score, on average, 0.13 logits higher on the PRE ($t = 0.03$). On average, students with higher scores on the EE Anatomy/Physiology and EMT Basics subsections obtained higher scores on the PRE. Every 10-scale point increase in Anatomy/Physiology raises the PRE by 0.17 logits ($t < 0.001$). Likewise, every 10-scale point increase in EE EMT Basics raises the PRE by score 0.11 logits ($t = 0.01$). Finally, every 10-scale point increase in Conscientiousness scale scores, decreases the PRE by 0.06 logits ($t = 0.03$). **Conclusion:** Although significant, the result is a statistical artifact due to multicollinearity, and this negative result should be ignored.

104. PARAMEDIC ATTITUDES TOWARD PARTICIPATION IN RESEARCH: A SYSTEMATIC REVIEW OF THE LITERATURE

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Background: Research is essential for the development of evidence-based paramedicine and is now recognized as an essential component of the discipline. As the profession grows and paramedicine based research is increasingly called upon to inform practice, meaningful paramedic participation supporting research becomes vital. However, increased system pressures and demands for service puts a considerable strain on paramedics raising concerns as to what extent research is a priority. Promoting research in paramedicine therefore may be contingent on paramedics' attitudes and experiences as participants in paramedicine research. **Objectives:** To identify paramedics' attitudes toward participation in prehospital research, we completed a systematic review of the literature. **Methods:** We searched MEDLINE, EMBASE, Evidence Based Medicine (EBM) Reviews, and the Cumulative Index to Nursing and Allied Health Literature (CINAHL) databases for combinations of relevant terms composed by an expert information specialist familiar with prehospital research from inception (of each database) until March 2015. We excluded commentaries, opinions, letters, conference proceedings or abstracts and non-English publications. One investigator (JEB) screened all titles and two investigators (JEB & MJE) per-

formed an independent hierarchical screening of abstracts and full-text articles (blinded to source) for inclusion. Differences were resolved by consensus. **Results:** We retrieved 2,801 titles from the search, of which 10 publications were retained for analysis. The kappa for abstracts, and full texts were 0.74 and 0.78, respectively. All articles were qualitative interviews or surveys. We discovered that paramedics are interested in research and believe it is important for advancing the profession and improving patient care. However, significant barriers exist (e.g., lack of funding, research training programs, dedicated time for research) that limit paramedics' involvement with research. **Conclusion:** Paramedics appear to support participation in research, believing it has both clinical and professional benefits; however, barriers to participation exist. Additional work is needed to determine ways to best engage non-participating paramedics and identify the strategies to mitigate potential barriers.

105. DIFFERENCES IN PREHOSPITAL PATIENT ASSESSMENT BETWEEN PEDIATRIC AND ADULT PATIENTS

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Background: A distinct set of skills, familiarity, and knowledge is required to assess pediatric compared to adult patients, and Emergency Medical Services (EMS) providers may not perform the same level of assessment skills in pediatric patients. **Objectives:** We sought to identify differences between prehospital patient assessments performed for pediatric vs. adult patients. **Methods:** We performed a retrospective review of ground EMS transports from a scene by 20 EMS agencies in a regional EMS system between July 1, 2013 and December 30, 2014. We collected data on patient and transport characteristics, vital signs, Glasgow coma score (GCS), pain scores, and lung sounds assessment. Multivariable logistic regression controlling for EMS service, gender, medical category, and transport distance was performed to assess for differences between pediatric and adult patients in individual components of patient assessment. **Results:** Of 232,999 patients transported to a hospital, cases were excluded that were inter-facility transports (44,349, 19.0%), cardiac arrest (1,976, 0.8%), or missing demographic data (5,074, 2.2%). A total of 182,321 patients were included. There were 171,150 (93.9%) adult patients (≥ 18 years) and 11,171 (6.1%) pediatric patients, including neonates (< 1 mon, $N = 187$), infants (1 mon–1 year, $N = 1,217$), toddlers (1–2 years, $N = 1,106$), early childhood (2–5 years, $N = 2,286$), middle childhood (6–11 years, $N = 2,357$), and adolescents (12–17 years, $N = 4,018$). Less pediatric patients had a full set of vital signs (HR, SBP, and RR) compared to adults (85.8% vs. 95.1%, OR 0.260, 95%CI 0.244–0.277), with the lowest proportions in the youngest age groups (51.3%, 64.5%, 73.9%, 83.6%, 91.7%, and 94.8%, respectively). Glasgow coma score was less frequent in pediatric patients vs. adults (77.8% vs. 78.9%, OR 0.907, 95%CI 0.864–0.951). In trauma patients ($N = 34,601$), pain score documentation was less frequent in pediatric patients (33.7% vs. 38.7%, OR 0.809, 95%CI 0.747–0.876). In respiratory patients ($N = 16,775$), pediatric patients had less frequent pulse oximetry (89.2% vs. 97.2%, OR 0.213, 95%CI 0.174–0.262) and similar assessment of lung sounds (94.3% vs. 95.7%, OR 0.819, 95%CI 0.639–1.050). **Conclusions:** There is a disparity between prehospital assessments of pediatric vs. adult patients, especially for patients in the youngest age categories. EMS providers would benefit from ad-

ditional education regarding pediatric patient assessment.

106. PREHOSPITAL PROVIDERS' PERCEPTIONS ON PROVIDING PATIENT AND FAMILY CENTERED CARE

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Background: A gap exists in understanding a provider's approach to delivering care that is mutually beneficial to patients, families, and other providers in the prehospital setting. **Objectives:** The purpose of this study was to identify attitudes, beliefs, and perceived barriers to providing patient and family centered care (PFCC) in the prehospital setting and to describe potential solutions for improving PFCC during critical pediatric events. **Methods:** We conducted a qualitative, cross-sectional study of a purposive sample of Emergency Medical Technicians (EMT) and paramedics from an urban, municipal, fire-based EMS system, who participated in the Pediatric Simulation Training for Emergency Prehospital Providers (PediSTEPPS) course. Two coders reviewed transcriptions of audio recordings from participants' first simulation scenario debriefings and underwent constant comparison analysis to identify unifying themes. Themes were verified through member checking with two focus groups of prehospital providers. **Results:** A total of 102 EMTs and paramedics participated in 16 audiotaped debriefing sessions. Four overarching themes, each with subthemes, emerged regarding the experience of PFCC by prehospital providers: (1) Perceived barriers included the prehospital environment, limited manpower, multitasking medical care, and concern for interference with patient care; (2) Providing emotional support comprised of empathetically comforting caregivers, maintaining a calm demeanor, and empowering families to feel involved; (3) Effective communication strategies consisted of narrating actions, designating someone to communicate with the family, speaking in lay terms, using the patient's name, summarizing during downtime, and conveying a positive first impression; and (4) Tactics to overcome parental barriers were maintaining a line of sight, preempting the next actions, removal, and return of a parent to the scene if necessary, and providing situational awareness. **Conclusion:** Based on debriefings from simulated scenarios, some prehospital providers identify the provision of emotional support and effective communication as important components to the delivery of PFCC. Other providers revealed several perceived barriers to providing PFCC, although potential solutions to overcome many of these barriers were also identified. These findings can be utilized to integrate effective communication and emotional support techniques into EMS protocols and provider training to overcome perceived barriers to PFCC in the prehospital setting.

107. A COMPARISON OF MEDICATIONS IN 38 PEDIATRIC EMS PROTOCOLS TO THOSE LISTED ON THE BROSELOW-LENGTH BASED TAPE

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Background: Pediatric Advanced Life Support guidelines set forth by the American Heart Association recommends use of a length-based resuscitation tape (LBT) by healthcare providers. Pediatric medication errors in the prehospital setting have been studied by numerous investigators, occur frequently and are potentially fatal. This study seeks to compare pediatric drug

dosages from large and small EMS agencies to those listed on the Broselow LBT and determine discordance rates. **Methods:** We first sought to determine the percentage of medications on the Broselow LBT found at incongruent dosages compared to the EMS protocols. We then determined the total number of medications from each EMS protocol that were not present on the Broselow LBT. For each EMS agency, the sum of incongruent medications and missing medications was divided by the total number of medications to determine the overall discordance rate for each EMS agency. Finally, we calculated the frequency of each of the medications in each EMS protocol, which were missing from the Broselow LBT, as well as those that were listed at incongruent dosages. **Results:** Thirty-eight EMS protocols were reviewed. Populations served by these agencies ranged from 291 to 2.49 million. Of medications listed in both the Broselow LBT and EMS protocol, 10% were listed at a dose at least 30% greater than that recommended by the EMS protocol. On average, 38% of EMS protocol medications were not listed on the Broselow LBT. This calculated to a total average medication discordance rate of 49% (Range 32–63%, SD 8%). We compared the average discordance of 49% (95% CI: 32%, 63%) against a hypothetical measure of 10% using a test for a difference in proportions. The calculated discordance was statistically greater than a standard of 10% ($p < 0.001$). Further analysis revealed that five medications represented 62% of the missing medications: Epinephrine 1:1000 IM, Ondansetron, Diphenhydramine, Morphine, and Albuterol. Three medications accounted for 84% of the incongruent dosages: Midazolam, Fentanyl, and Diazepam. **Conclusion:** A significant discrepancy exists between the pediatric drug dosages found in 38 EMS protocols and those listed on the Broselow Length-Based Tape.

108. 5-YEAR EXPERIENCE WITH PREHOSPITAL ANTIARRHYTHMIC MEDICATION IN PEDIATRICS IN A STATEWIDE EMS SYSTEM

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Background: Antiarrhythmic medications are frequently included in EMS pediatric protocols despite little evidence supporting their safety/efficacy in this setting. **Objectives:** The purpose of this study is to analyze the 5-year statewide experience with antiarrhythmic medications in pediatrics. **Methods:** This was a retrospective analysis of a statewide EMS information system (EMSIS) conducted from 1/1/2010 to 12/31/2014. The study population was children <13 years old who received prehospital adenosine, amiodarone, or lidocaine, the three antiarrhythmic medications permitted in state EMS protocols, for presumed tachycardic arrhythmia. Cases were excluded for interfacility transfer, cardiac arrest upon EMS arrival, use of medication for other than arrhythmia, or age/medication documentation errors. Records were obtained from the EMSIS using filters for patient age <13 years old and administration of the three medications. Standard statistical analysis was performed. **Results:** During the study period there were 6,683,098 records within the EMSIS, 221,894 (3.3%) were <13 years old. Medications were administered to 13,434 patients within this age group (6.1%). The three study medications were administered to 78 patients. However, 71 of these cases were excluded leaving only 7 cases for analysis. Reasons for exclusion included interfacility air transport (43), interfacility ground transport (7), presentation in cardiac arrest (5), lidocaine for intraosseous anesthesia (7), age documentation error (4), medication documentation error (3), duplicate patient from

a second ALS agency (1), and no narrative for review (1). Among the 7 remaining cases for analysis, a single dose of lidocaine was used unsuccessfully for a 10-year-old with reported stable ventricular tachycardia (vs. LBB). Adenosine was administered to 6 patients for reported stable paroxysmal supraventricular tachycardia, with 3 patients converting to sinus rhythm after receiving a single dose. The 3 patients who did not convert received 3 escalating doses of adenosine consistent with weight-based protocols. Amiodarone was not administered. The median age (range) of patients receiving antiarrhythmic medications was 9 years (26 days–12 years). There were no apparent adverse effects reported from the medications. **Conclusion:** Antiarrhythmic medications are very rarely given in the prehospital setting to children under 13 years of age. In this statewide EMS system we identified only 7 patients to receive these medications over 5 years.

109. IMPROVING PREHOSPITAL PEDIATRIC MEDICATION VOLUMETRIC ADMINISTRATION WITH A PROTOCOL SPECIFIC WEIGHT-BASED REFERENCE TOOL

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Background: Prehospital pediatric emergencies are far less frequent than adult emergencies, accounting for 10% or less of total calls. In addition, the utilization of prehospital medications for pediatric patients is even less common, accounting for as few as 1.4% of all procedures. Because providers uncommonly encounter these types of situations, the literature indicates that there are significant error rates in medication dosages administered to pediatric patients. There have been studies analyzing the use of weight-based dosing and volume of administration utilizing pediatric reference tools, but none to our knowledge that have also scrutinized these tools by employing hands on volume extraction into the correct size syringe. **Methods:** Prehospital advance life support (ALS) providers were randomized into control and test groups. The control group was given access to any references of their choice whereas the test group was given only the pediatric medication reference tool. Both groups were given a 1, 3, 6, and 12 milliliter syringe. Subjects were instructed to calculate the appropriate weight-based dose of epinephrine and midazolam by drawing up the appropriate volume in one of the syringes provided. **Results:** Of the 272 ALS prehospital care providers participating, 139 answered utilizing the pediatric medication reference tool, and 133 answered without the tool. The group receiving the reference card was significantly more likely to provide the correct dose for midazolam (Versed) (87.0% vs. 53.4%; $p < 0.001$) and epinephrine (74.1% vs. 55.3%; $p = 0.001$). After adjusting for other factors, the use of the reference card was significantly associated with an increased likelihood of correct dosing for midazolam (Versed) (OR = 6.80, $p < 0.001$) and epinephrine (OR = 2.54, $p = 0.001$). **Conclusion:** The pediatric protocol specific weight-based reference tool enabled prehospital care providers to establish weight-based medication doses and volumes of medication administration more accurately than providers without access to this tool. Further education on syringe usage, Broselow tape limitations, and enhanced electronic patient care reporting (ePCR) medication documentation capturing could be of benefit and assist in decreasing pediatric prehospital medication administration errors.

110. TRENDS IN NALOXONE USE IN PEDIATRIC PATIENTS IN A LARGE URBAN EMS SYSTEM

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Background: Death from opiate overdose poses a large societal burden. Naloxone is a safe opiate reversal agent. The CDC reported significant increased heroin overdose deaths across 28 states between 2010 and 2012. Similar opiate abuse trends have been seen in the pediatric population. It is unclear if the described increase in opiate use among pediatrics has led to an increase in the use of naloxone among prehospital providers for pediatric patients. **Objectives:** We describe prehospital naloxone utilization among pediatric patients in a large urban EMS system. **Methods:** This is a retrospective case review study. We collected data from a prehospital database from an urban EMS system. Children less than 18 years old receiving naloxone in the prehospital setting between 2010 and 2014 were included. A chart review of the individuals included in the study was performed. Basic demographic data was collected including age, race, indication, route of delivery, and medication effect. We describe the number of cases per year as well as the median age of the patients. **Results:** Thirty-six children out of 36,346 pediatric encounters received naloxone. By comparison, total annual naloxone use from 2012 to 2014 nearly doubled, with 1,063 doses administered in 2014. The median age of all pediatric patients receiving naloxone is 16 (IQR 11–17). Twenty-five (69.4%) of the patients were between the ages of 14 and 17 with 15 (44.4%) of those being 17-year-olds. The number of naloxone use ranged from 5–9 patients annually over the 5 years of the study. Indication, route, and outcome was missing in 12 records. Of the remaining 24 patients, the two most common indications were pinpoint pupils (54%) and depressed respirations (33%). Intravenous Naloxone was given in all but one patient. Most patients (71%) had clinical improvement after delivery of Naloxone. **Conclusion:** Prehospital use of naloxone in the pediatric population remains uncommon. There is not increased naloxone use among pediatric patients as has been described in the adult literature. Most naloxone use in the study population occurred in those individuals between 14 and 17 years old.

111. HIDE OR GO SEEK: DO MORE PEDIATRIC ENCOUNTERS MAKE BETTER PARAMEDICS?

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Background: The primary goal of paramedic education is to produce competent entry-level paramedics with demonstrated critical thinking ability. Although revised educational standards exist, EMS educators do not have a reliable method for assessing student competency. **Objectives:** This study sought to better understand the association between the quantity and role of pediatric encounters compared to cognitive testing outcomes after completion of clinical and field experiences. **Methods:** A retrospective review and descriptive study of data abstracted from the web-based Fisdap[®] system, a student clinical experience tracking system, for the years 2008–12. Only clinical data from shifts occurring before the first Fisdap[®] Paramedic BLUE exam attempt was used. Scaled scores of the pediatric questions using the Rasch model to create a continuous “logit” variable and obtain latent scores on the pediatric scale. After obtaining the scale scores, a linear model was fit to predict scale score using

pediatric field and clinical encounters, controlling for ethnicity. **Results:** For the Paramedic BLUE exam's pediatric-specific questions, the average student logit score was 2.05 ± 0.90 , which meant that students were likely to get the answer correct 88% of the time. Paramedic students saw an average of 24.62 ± 16.61 pediatric patients in their clinical rotations and 5.57 ± 4.65 pediatric encounters in the field internship. Every clinical rotation pediatric patient encounter contributed 0.2% to the probability a paramedic student will answer the pediatric test item successfully. For field internship pediatric encounters, each pediatric encounter contributed 0.4% to the probability a paramedic student will answer the pediatric test item successfully. Over an average of 33 pediatric patient encounters, the overall effect will be an additional 6.6–13.2% improvement in paramedic student scoring on the pediatric-specific test questions of the Paramedic BLUE exam. Prior to that student having any pediatric patient encounters, the effect of an African-American or Latino background was strongly but negatively associated with paramedic student success answering pediatric-specific test questions on the Paramedic BLUE exam. **Conclusion:** Field encounters, rather than clinical encounters, have a greater effect on student exam performance regarding pediatric-specific questions. Ethnic differences should also be considered.

112. PATTERNS OF RIB FRACTURES BASED ON PRIMARY DIRECTION OF FORCE IN MOTOR VEHICLE COLLISIONS

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Background: Rib fractures significantly altered the cardiovascular and respiratory functioning of occupants injured in motor vehicle collisions (MVCs). These injuries also portend increased severity of injury and need for additional prehospital interventions. Although the biomechanics of rib fractures have been previously studied, there has been no data published at the granularity of individual rib fracture levels based on mechanism. **Objectives:** The purpose of this study was to elucidate patterns of rib fractures from MVCs based on information available to the prehospital provider. **Methods:** Data were obtained from the Crash Injury Research and Engineering Network (CIREN) database. CIREN collects detailed medical and vehicle data from real-world MVCs. Occupants were identified for this study based on the inclusion criteria: age ≥ 16 years, year of collision 2005–14, and collision resulting in one or more rib fracture. The frequency of fractures based on rib level and laterality was first examined for all collisions. The data was then analyzed based on primary direction of force (PDOF) and by seating position vs. direction of impact. **Results:** The CIREN database contained 928 cases that met the inclusion criteria; 166 cases were excluded due to incomplete information. This resulted in 762 cases for analysis with a total of 3,637 rib fractures. Of these cases, 700 were non-rollover collisions. When the data from all collisions was analyzed, the incidence of rib fractures appeared to follow a truncated normal distribution bilaterally. The frequency of collisions based on PDOF showed that rib fractures were most commonly caused by frontal impacts (69%) and least commonly caused by rear-impacts (<1%). Occupants are slightly more likely to sustain rib fractures of the inboard ribs in frontal collisions and significantly more likely to fracture ribs on side of impact in lateral impacts. **Conclusion:** The results of this study indicate that rib fractures are most common in the middle to upper thorax in all MVCs. Prehospital

providers should have a low level of suspicion for rib fractures in rear-end collisions. In the case of lateral impacts, providers should be aware that rib fractures are much more common on the side of impact, regardless of seating position.

113. EVALUATION OF THE MODIFIED SHOCK INDEX AS A PREHOSPITAL ASSESSMENT TOOL FOR SERIOUSLY-INJURED TRAUMA PATIENTS

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Background: The Modified Shock Index (MSI) is a newer, non-invasive diagnostic tool that has demonstrated a predictive capability for hypovolemic shock and mortality in hospitalized trauma patients. The MSI is calculated by dividing the heart rate by mean arterial pressure, with any values below 0.7 or above 1.3 suggesting shock and increased risk for death. This study examines MSI's capability to predict critical injury in the prehospital setting in hopes for an additional assessment tool, where limited diagnostics prevent detection of occult hemorrhage that would lead to shock. **Objectives:** The primary goal of this study was to correlate prehospital and early emergency department (ED) MSI to the Injury Severity Score (ISS) and length of hospital stay (LOS). **Methods:** This 15-month retrospective study examined 242 seriously-injured adult trauma patients transported by emergency medical services (EMS) to the region's Level 1 Trauma Center. Fifty-one patients met the inclusion criteria, which ensured they were unaffected by known exogenous variables that would affect blood pressure and heart rate. These patients were divided into two groups by the criteria of length of stay or the ISS. **Results:** The correlation between MSI to ISS at the ED was found to have a diagnostic odds ratio (DOR) of 8.25. However, in the prehospital setting, the MSI DOR dropped to 4.67 with further concern that the bulk of the correlations were due to the negative predictive value (npv = 0.93). The positive predictive value (ppv) offered poor predictive capabilities at ppv = 0.27. However, at the ED, the MSI DOR increased to 8.67 with the ppv = 0.50 in the ISS test. For LOS, the DOR in the prehospital setting was 4.63 with an npv = 0.93 and ppv = 0.27. At the ED, the LOS DOR increased to 17.50, with npv = 0.95 and a low ppv of 0.25. **Conclusion:** This dataset suggests that the MSI offers a better assessment in the ED setting than for EMS, likely due to the increased time needed to develop a detectable hypovolemic shock state. This study suggests prehospital use of the MSI has the potential to exclude a large number of patients that should be considered as critical.

114. IMPLEMENTATION OF NAEMSP JOINT POSITION STATEMENT ON "EMS SPINAL PRECAUTIONS AND THE USE OF THE LONG BACKBOARD" INTO STATEWIDE TREATMENT PROTOCOLS

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Background: The National Association of EMS Physicians (NAEMSP) issued a joint position statement (JPS) with the American College of Surgeons Committee on Trauma (ACS-COT) on "EMS spinal precautions and the use of the long backboard" published in March of 2013, which recommended use of selective spinal immobilization (SSI) and judicious use of backboards. The American College of Emergency Physicians (ACEP) issued a similar position

statement in January of 2015. The majority of states issue statewide treatment protocols (STPs) that are either mandatory or serve as a guide for medical directors. **Objectives:** The purpose of this investigation is to describe the extent to which STPs incorporate the JPS on spinal precautions into their protocols. **Methods:** Standardized review of all STPs for use of long backboards as well as SSI protocols. Revision was also captured. **Results:** Thirty-six out of fifty states issue STPs, 56% are mandatory. A total of 69% of STPs have an SSI protocol, whereas 33% actively discourage use of long backboards. Only 40% of STPs issued after the JPS incorporated the recommendations on spinal precautions and use of long backboards. **Conclusion:** Prehospital care is increasingly driven by evidence based practices and reinforced by professional bodies such as NAEMSP, ACS, and ACEP. Despite this, there is still variation in adoption of what is now widely considered standard of care with only 31% of STPs conforming to the JPS. Protocol revision cycles may be a contributing factor for the relatively low number of states conforming to the JPS; however, when only considering protocols issued after the JPS, the number of conforming STPs only rises to 40%. It is possible that 2.5 years is an inadequate time period for complete adoption. Further study to better understand time to implementation of a position statement/evidence based practice, as well as barriers to integration is needed.

115. FACTORS ASSOCIATED WITH APPROPRIATE SPINAL IMMOBILIZATION AND LONG BACKBOARD USE

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Background: The 2013 NAEMSP/ACS Committee on Trauma joint position statement on long backboard and c-spine immobilization included criteria defining appropriate use of these treatments. **Objectives:** This study sought to identify factors associated with the appropriate use of long backboard immobilization following release of these guidelines. **Methods:** This was a retrospective review of collected data from Fisdap, a database of prospectively reported clinical field experiences for paramedic, AEMT, and EMT students. Inclusion criteria included student consent to research, data validated by preceptor as good data, and patient encounter date of 2013 and 2014. The association of US geographic region where the encounter occurred (West, North, South, East), student training level (EMT/AMET vs. paramedic), patient race/ethnicity (African American, Caucasian, Other, Hispanic), patient gender (male vs. female), and patient age (≤ 18 ; 19–64; ≥ 65) with appropriate backboard use was evaluated using logistic regression. Appropriate use was defined according to the 2013 position statement criteria and derived from data elements from Fisdap. **Results:** A total of 24,020 runs (2013 = 15,417; 2014 = 8,603) met inclusion criteria and were analyzed. Overall, 82.4% of patients were appropriately long backboarded, 13.9% had inappropriate placement, and appropriateness could not be determined in 3.7% of patients. Encounter year (2013 = 77.9%; 2014 = 90.3%), geographic location [Midwest (OR = 1.54; 95% CI 1.3–1.8); South (OR = 1.24; 95% CI 1.10–1.40); reference = West],

and race (African American; OR = 1.22; 95% CI = 1.10–1.36; reference = Caucasian) were all significant factors associated with higher levels of appropriate placement. Encounters with an AEMT student (OR = 0.81; 85% CI 0.71–0.92) and encounters with a patient ≤ 18 (OR = 0.74; 95% CI 0.66–0.82) or ≥ 65 (OR = 0.75; 95% CI 0.69–0.82) were associated with a lower likelihood of appropriate placement. **Conclusion:** Factors associated with higher likelihood of appropriate long backboard use include patient encounter in 2014, encounters in the Midwest or South, and African American patient race. Encounters with an AEMT students and encounters with patients ≤ 18 or ≥ 65 were associated with a lower likelihood of appropriate long backboard use.

116. IMPACT OF THE NAEMSP GUIDELINES FOR SPINAL IMMOBILIZATION AND LONG BACKBOARD APPLICATION ON USAGE RATES BETWEEN 2010 AND 2014

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Background: Previous research has demonstrated that use of the long backboard for spinal immobilization in trauma patients may cause more harm than good, prompting the release of the 2013 NAEMSP/ACS Committee on Trauma joint position statement on long backboard and c-spine immobilization usage. **Objectives:** This study evaluated whether the release of this position statement impacted the rates of long backboard and c-collar usage. **Methods:** This study was a retrospective review of prospectively collected data from paramedic, AEMT, and EMT students entering data into Fisdap, a database of prospectively reported clinical field experiences. Inclusion criteria included student consent to research, data validated by preceptor as good data, and patient encounter dates between 2010 and 2014. Change in the rate of long backboard and c-collar use per year was analyzed using logistic regression. **Results:** A total of 1,105, 818 runs (2010 = 202, 858, 2011 = 216,980, 2012 = 265,403, 2013 = 253,718, 2014 = 166,859) met inclusion criteria. Rate of long backboard use decreased from 7.90% in 2010 to 1.73% in 2014, resulting in a 30% decrease in long backboard use year over year (OR = 0.70, 95% CI = 0.69–0.70). Rate of c-collar use decreased from 8.25% in 2010 to 3.95% in 2014, which was an 18% year over year decrease. When the years were grouped into pre (2010–12) and post (2013–14) position statement time periods, there was a much faster year over year reduction in usage rates for long backboards (OR = 0.5899; 95% CI: 0.5648–0.6161) and c-collar spinal immobilization (OR: 0.7871; 95% CI: 0.7635–0.8114) in the post position statement time period. **Conclusion:** The rate of long backboard and c-collar spinal immobilization has been declining since 2010, which included time prior to the release of the 2013 position statement paper. Release of the position statement appears to have accelerated the decrease in rates of long backboard and c-collar immobilization compared to the pre-position paper period.

117. ASSOCIATION BETWEEN ALTERED STABILITY OF SHOCK INDICES BETWEEN PREHOSPITAL AND IN-HOSPITAL PERIOD AND ED MORTALITY IN SEVERE TRAUMA PATIENTS USING EMERGENCY MEDICAL SERVICES

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Background: Shock index (SI) is easily measured in prehospital field and is useful to pre-

dict mortality in injured patients. **Objectives:** In this investigation, we assessed the association between altered stability of SI between prehospital to the in-hospital period and mortality during emergency department (ED) stay in severe trauma patients using emergency medical services (EMS). **Methods:** This is prospective observational study using EMS Severe Trauma Database (EMS ST DB) in South Korea. Inclusion of EMS ST DB includes adult patients with abnormal revised trauma score who were transported by EMS in 2 provinces of South Korea between Jan and Dec 2011. Trained medical record reviewers from Korean CDC collected clinical information from EMS run sheets and hospital medical records using a standardized registry. We assessed SI during prehospital and in-hospital stay. Prehospital SI (PSI) was defined as heart rate divided by systolic blood pressure measured by EMS provider at the scene. Hospital SI (HSI) was assessed from initially measured vital signs at ED. If SI was $0.5 < SI < 0.9$, we defined it as stable SI. We categorized alteration of prehospital and in-hospital SI by 4 groups; stable PSI and HSI (SPSH), unstable PSI and stable HSI (UPSH), stable PSI and unstable HSI (SPUH), unstable PSI and HSI (UPUH). The primary outcome was mortality during ED stay. Our secondary outcome was admission mortality. We performed descriptive analysis for demographic and clinical findings. We conducted multiple logistic regression to assess the association between 4 types of SI alteration and ED mortality. We adjusted the model by age, gender, injury mechanism, injury severity score, mental status by AVPU, and operation. **Results:** During the study periods, 9,668 cases with severe trauma were registered into EMS ST DB. Among them, the value of PSI was 1.2 ± 6.2 and HSI was 0.9 ± 1.2 . Case numbers of SPSH, UPSH, SPUH, and UPUH was 3,290 (34.0%), 2,345 (24.3%), 1,128 (11.7%), and 2,905 (30.1%), respectively. Compared to the SPSH group, odds ratio for ED mortality of UPSH, SPUH, and UPUH was 1.97 (95% CI: 1.03–3.77), 7.79 (4.36–13.9), and 119.7 (67.3–182.3), respectively. **Conclusion:** Alteration of stability of SI between prehospital to in-hospital period was associated with higher ED Mortality in severe trauma patients using emergency medical services.

118. AGE-RELATED RISK OF DEATH IN PATIENTS WITH MAJOR TBI: IMPLICATIONS FOR TRAUMA TRIAGE GUIDELINES

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Background: The 2011, Trauma Triage Guidelines identify patients with age ≥ 55 as those that "might require Trauma Center (TC) care." This recommendation is based on the significant increase in the odds of death following injury with each year in age above 55. **Objectives:** We sought to determine if, in subset of trauma patients with moderate or severe Traumatic Brain Injury (TBI), age could be used identify a population at higher risk of death. **Methods:** This was an observational cohort study evaluating the association between mortality and age after of moderate/severe TBI cases (CDC Barell Matrix Type 1, or ICD-9 head-region severity score ≥ 3 , or AIS head-region severity score ≥ 3) in the Excellence in Prehospital Injury Care (EPIC) TBI Study (NIH/NINDS: 1R01NS071049; ClinicalTrials.gov #NCT01339702) from 1/1/07–3/31/14. Cases were excluded if: transferred out of the reporting TC, missing age, age ≥ 100 year, or were missing risk

adjustment measures. A logistic regression model adjusted for: gender, race, ethnicity, inter-facility transfer, trauma type, head injury severity score, injury severity score, prehospital intubation, lowest prehospital systolic blood pressure (SBP), hypoxia, payer source, and TC. **Results:** There were 17,105 subjects and after excluding those cases mentioned above 17,032 patients were included. There were 1,154 subjects below 10 years of age (6.8%) and 312 at or above 90 years (1.8%). The estimated death rate over the age range from 0 to 99 years obtained from the logistic regression model demonstrates a very high risk-adjusted probability of mortality in young children dropping to a low in older children and teenagers. The adjusted risk plateaus between ages 20–40 with a significant increase and a higher plateau between 40 and 55. Finally, there is a dramatic increase throughout each of the decades of life above the 50s. **Conclusion:** Current Triage Guidelines do not take into account TBI-specific, age-related risks. These findings raise the specter that the adjusted risk of death in patients with moderate or severe TBI may increase in patients significantly younger than the current guideline suggests. Age 40 may be a more appropriate threshold for age-related triage considerations in patients with TBI.

119. ANALGESIA ADMINISTRATION FOR TRAUMATICALLY INJURED PATIENTS IN A CANADIAN EMS SYSTEM

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Background: Pain management in traumatically injured patients is an often delayed component of overall patient care. **Objectives:** We seek to describe characteristics of Advanced Care Paramedics' use of a Medical Directive (MD) to provide analgesia for isolated hip or extremity trauma. **Methods:** This is a retrospective analysis of consecutive electronic Patient Care Reports (ePCR) with Advanced Care Paramedic response to traumatically injured patients in the catchment area of a single Level 2 Trauma Centre. Inclusion criteria are records containing a trauma related ePCR code between December 1, 2014 and May 31, 2015 where at least one responding Paramedic is Advanced Care. Exclusion criteria are patients < 18 years, vital signs absent patients, records incorrectly coded as trauma (determined by majority of 3 reviewers), and incomplete records. The remaining ePCRs are examined and data is extracted to determine eligibility for implementation of the MD and characteristics of analgesia administration. **Results:** A total of 688 ePCRs met search criteria representing 644 patients; 62 (9.6%) met exclusion criteria for a final study population of 582. Analysis is ongoing. To date, prehospital data has been analyzed for 217 patients (260 reviewed, 43 excluded). A total of 130 (60%) qualified for implementation of the MD. Of these, 32 (24.6%) received analgesia. The most common analgesic administered was Fentanyl (16, 50%), followed by Morphine (10, 31.25%). The mean time from patient contact to analgesic administration was 20 min. Mean age of patients who received analgesia was 59 (range 19–90). The mean age of patients who qualified for the MD but did not receive analgesia was 65 (range 19–94). **Conclusion:** Despite the ability to administer analgesia to patients with isolated hip or extremity trauma, preliminary data analysis shows that Advanced Care Paramedics in this EMS system are administering analgesia to less than a quarter of eligible patients. Further analysis of this data set may provide insight into non-modifiable characteristics impacting

this rate. This data may prove useful to EMS educators when providing education to practitioners about pain management. Further studies are required to better understand the impact of paramedic characteristics on analgesia administration.

120. TIMING AND SAFETY OF PREHOSPITAL TRANEXAMIC ACID ADMINISTRATION BY A UNIVERSITY AFFILIATED HELICOPTER SERVICE

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Background: Tranexamic acid (TXA) is an antifibrinolytic agent that competitively prevents the conversion of plasminogen to plasmin. The CRASH-2 trial revealed TXA administration reduced the risk of death in trauma patients. However, timing is critical (administration in the first hour showed the greatest benefit while administration beyond 3 h increased mortality). TXA has also been shown to significantly increase the incidence of deep venous thrombosis (DVT) in certain populations. The MATTERS study reported that DVT was more often recognized among patients receiving TXA; however, these patients had higher injury severity scores that may account for this finding. No study has looked at the effects of prehospital administered TXA bolus on patient outcomes or resultant TXA attributed complications. **Objectives:** We hypothesize that prehospital TXA administration is feasible and not associated with increased risk of venous thromboembolism. **Methods:** This is a retrospective case analysis of 30 patients receiving a TXA bolus by a University affiliated helicopter service during transport of patients with massive ongoing blood loss at the injury scene or receiving blood transfusions prior to transfer to our center for definitive management. We evaluated time from injury to bolus TXA administration, follow up TXA infusion on arrival, and any possible TXA associated complications. **Results:** This cohort was 57% male (average age 46 years). A total of 57% were involved in motor vehicle accidents, 30% had penetrating trauma, and 13% medically related bleeding (GI, vaginal). A total of 70% were scene transports. Overall mortality was 10%. Average time to TXA administration was 53.36 mins following injury, with 60% receiving the TXA infusion on hospital arrival. Only 3 patients had vascular occlusions; 2 were associated with underlying fractures; and 1 was diagnosed as chronic in an oncology patient. **Conclusions:** In our setting, EMS was able to administer prehospital TXA within one hour of injury, on average, and within 3 h in 100% of cases. We did not observe any significant complications that could be attributed to TXA. Notably, 40% of patients did not receive the recommended TXA infusion after the prehospital bolus. Opportunities exist to ensure this infusion is given.

121. TRADITIONAL BLEEDING CONTROL STRATEGIES: A SYSTEMATIC REVIEW USING GRADE METHODOLOGY

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Background: Bleeding control is an important first aid/EMS intervention. Traditional bleeding control strategies, in addition to direct pressure, include cold therapy, elevation of extremity, and pressure over proximal blood vessels. **Objectives:** Among adults and children with bleeding (P), does application of localized cold therapy, elevation of extremity, and/or application of pressure over proximal pressure points (I), compared with direct pressure alone

(C), change overall mortality, hemostasis, major bleeding, complications, and hospital length of stay (O)? **Methods:** This systematic review was conducted by the International Liaison Committee on Resuscitation (ILCOR) First Aid Task Force. Pubmed, EMBASE, and Cochrane databases were searched up to November, 2013. Human studies were independently reviewed by two reviewers for PICO criteria with discrepancy resolved by consensus. The GRADE approach was used to develop the question, prioritize outcomes, and appraise evidence. **Results:** There were 1,392 citations retrieved with two randomized controlled trials (RCTs) that met inclusion. Neither study involved first aid/EMS therefore quality was downgraded for indirectness, and additionally downgraded for bias and imprecision. The two RCTs did not address mortality or hospital length of stay, but addressed hemostasis and major bleeding. Very low quality evidence was reported by one RCT involving 50 patients demonstrating a statistically significant benefit in the reduction of femoral hematoma formation in percutaneous coronary intervention patients receiving cold pack therapy compared with sandbags for direct pressure (quantitative data unavailable). Very low quality evidence was reported from the other RCT involving 80 patients suggesting cold compression is superior to compression alone in the reduction of total body blood loss and extravasation in total knee arthroplasty patients (mean difference total body blood loss 610 mL; 95% CI, 415.6–804.4, and in extravasation 357 mL; 95% CI, 184.6–529.3). For the outcome of complications no significant findings were reported. **Conclusion:** There was no evidence to directly compare traditional bleeding control strategies to direct pressure alone in the first aid/EMS setting. Interpretive caution is required when generalizing these findings outside of the study settings as the methods of cold therapy are different to those traditionally employed in the first aid/EMS milieu. Results of this systematic review can be used by first aid/EMS leaders to inform evidence-based bleeding control strategies.

122. WET VS. DRY BURN DRESSINGS IN THE FIRST AID SETTING: A SYSTEMATIC REVIEW USING GRADE METHODOLOGY

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Background: The treatment of burns is an important first aid/EMS intervention. It is unknown whether wet (e.g., saline soaked gauze) or dry dressings (e.g., plastic wraps) are preferable for the first aid/EMS treatment of burns. **Objectives:** To answer the question: "Among adults and children with thermal injuries (P), does the use of a wet dressing (I), compared with dry dressing (C), change complications, pain, tissue healing, need for advanced medical care, patient satisfaction, or rates of fasciotomy (O)?" **Methods:** This systematic review was conducted by the International Liaison Committee on Resuscitation (ILCOR) First Aid Task Force. Pubmed, EMBASE, and Cochrane databases were searched up to November, 2013. Definitions of what constitutes a "wet" vs. "dry" dressing were created through reviewer consensus and applied to the inclusion criteria. Wet dressing were defined as containing a moist agent applied directly to the burn, dry dressings did not have a moist agent. Citations were independently reviewed by two reviewers and the GRADE approach was used to synthesize findings and appraise evidence. **Results:** There were 2,038 citations retrieved, 2 RCTs, and 1 non-RCT met the inclusion criteria.

No studies addressed first aid/EMS situations; therefore quality was downgraded for indirectness, and additionally downgraded for risk of bias and/or imprecision. Low-quality evidence from the first RCT recruited 104 subjects with superficial burns comparing honey ("wet") dressings to silver sulfadiazine-impregnated gauze ("dry"). This study favors honey for: resolution of infection at 7 days (RR, 12.40; 95% CI, 4.15–37.00), the reduction of hypergranulation tissue, post-burn contracture, and hypertrophic scars (RR, 0.13; 95% CI, 0.03–0.52), and mean days to healing (mean difference: 7.80; 95% CI, –8.78–6.63). The second RCT recruited 100 patients with partial thickness burns comparing honey ("wet") with potato peels ("dry"). This study favors honey for: resolution of infection at 7 days (absolute risk reduction 0.90; 95% CI, 0.74–0.95) and mean days to healing (mean difference: 5.80; 95% CI, –6.68–4.92). **Conclusion:** There was no evidence to directly compare wet to dry dressings in the first aid/EMS treatment of thermal burns. Included low-quality evidence suggests that honey may be beneficial, but interpretive caution is required as both studies were from a single site.

123. SPATIOTEMPORAL AED LOCATION OPTIMIZATION

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Background: Mathematical optimization can be used to plan future AED placement to maximize out-of-hospital cardiac arrest (OHCA) coverage. Many public access AEDs are placed in locations without 24/7 access. AED coverage can be overestimated unless temporal availability is considered. **Objectives:** To develop a new spatiotemporal AED location optimization model that accounts for both spatial and temporal information. **Methods:** We identified all atraumatic public-location OHCA occurring in Toronto, Canada from Jan. 2006–Aug. 2014. We gathered location and operating hour data for 4,898 buildings that were used as potential sites for AED placement. We extended a previously published spatial optimization model, which identifies locations to place AEDs that maximize the number of historical OHCA occurring within 100m of an AED. The new spatiotemporal model finds AED locations that maximize the number of OHCA occurring within 100 m of an available AED, considering when the OHCA occurred ("actual coverage"). We then compared the spatial and spatiotemporal models on actual coverage of out-of-sample OHCA using 10-fold cross validation. Statistical analysis was performed using McNemar's test. **Results:** We identified 2440 atraumatic public-location OHCA. AED locations chosen by the spatiotemporal model outperformed those chosen by the spatial model by 26.1% in actual coverage ($p < 0.001$). Coverage improvement was observed at all times of day: daytime (11.2%), evening (37.4%), and night (292.3%). Equivalently, 40.2% fewer AEDs are needed when using the spatiotemporal model to reach the same level of actual coverage provided by AEDs located according to the spatial model. **Conclusion:** Spatiotemporal optimization can maximize actual OHCA coverage by accounting for AED availability when identifying future AED locations. The largest gains occurred during the evening and night, which is when the largest coverage losses were experienced by Toronto's existing AEDs.

124. ANALYSIS OF PREHOSPITAL OPIOID-RELATED CARDIAC ARRESTS IN A STATEWIDE EMS INFORMATION SYSTEM AND THE POTENTIAL

PREVENTATIVE VALUE OF NON-PARAMEDIC FIRST RESPONDER NALOXONE

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Background: Death rates from heroin and prescription opioid pain relievers (POPR) have doubled and quadrupled, respectively. Paramedic administered naloxone is an effective, safe opioid antidote. Many recommend naloxone for non-paramedic first responders (NPFR) despite limited evidence that this will prevent opioid-related cardiac arrests (ORCA). **Objectives:** The purpose of this study is to determine the potential for NPFR-naloxone to prevent ORCA in a statewide EMS system. **Methods:** This retrospective analysis of a statewide EMS information system (EMSIS) was conducted from 7/1/2013 to 6/30/2014. Data were obtained using a primary search for impression of cardiac arrest and drug overdose. An alternate search was done using opiate-related keywords and a cardiac arrest filter. A manual analysis of the record narratives was done categorizing cases as ORCA-suspected (opioid reported by name, injectable drug paraphernalia present, or clinical response to naloxone occurred); non-ORCA (clearly not ORCA); and ORCA-indeterminate. ORCA-suspected and ORCA-indeterminate were further analyzed to determine if NPFR-naloxone might have prevented ORCA. Standard descriptive statistical analysis was performed. **Results:** During the study period 1,537,334 records were in EMSIS, with 14,079 (0.9%) cardiac arrests. The primary search identified 76 potential ORCA cases with 511 additional obtained from the alternate search. The narrative analysis identified 164 ORCA-suspected cases (40 primary/124 alternate); heroin (108, 65.9%), POPR (53, 32.3%), and unknown opioid (6, 3.7%). The median (IQ) age was 38.2 (28, 49) years. Ninety-seven (59.0%) were male with 153 (93.3%) presenting in arrest, 39 (23.8%) DOA. There were 129 (78.7%) unwitnessed arrests, and 22 (13.4%), 8 (4.9%), and 1 (0.6%) witnessed by bystanders, EMS, and police, respectively. Three (1.8%) presented in a shockable rhythm. Paramedic response time (median/90%ile) was 6.0/12.0 min. Opportunities for pre-arrest NPFR-naloxone were identified in 7 (4.3%) cases. However, all of these developed ROSC, with 4 having a final GCS >13. Three (1.8%) ORCA-suspected patients who had signs of life upon NPFR arrival, promptly arrested, obtained ROSC but remained unresponsive might have benefited from NPFR-naloxone. **Conclusion:** ORCA was usually unwitnessed, associated with non-shockable rhythms, and occurred prior to NPFR arrival. The opportunity for NPFR-naloxone to prevent ORCA was not identified. Further studies are needed to determine the life-saving benefit from NPFR-naloxone.

125. EFFECT OF AN IMPEDANCE THRESHOLD DEVICE ON ETCO2 IN OUT-OF-HOSPITAL CARDIAC ARREST IN A SYSTEM USING MODIFIED MINIMALLY INTERRUPTED CPR WITH CONTROLLED RATE

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Background: Use of an impedance threshold device (ITD) in conjunction with modified minimally interrupted CPR (mmicpr) with controlled rate would result in increased ETCO2 as a surrogate marker of increased perfusion. **Methods:** Retrospective alternate interventional study design. Patients 18 years or older with non-traumatic out-of-hospital car-

diac arrest and ETCO2 data were included. ETCO2 was sampled using a micro-stream device placed between the bag and the ITD and measured by a LIFEPAK 12 (Physio-Control, Inc.). Continuous compressions were started immediately with a 10:1 compression ventilation ratio using bag-mask ventilation (BMV). Advanced airways were only used if BMV failed. Compression rate was controlled with the use of a metronome set at 100 for the ITD group and 112 for the non-ITD group. A total of 75 non-selected sequential cases during 2014 for each group were reviewed. The first ETCO2 was recorded (X) then 5 (X + 5) and 10 (X + 10) minutes later. ETCO2 data collection stopped with ROSC or discontinuation of resuscitation. **Results:** Mean first ETCO2 with ITD (X) 29.15, without ITD 25.42 (p = 0.155). Mean ETCO2 (X + 5) with ITD 30.86, without ITD 21.42 (p < 0.001). Mean ETCO2 with ITD (X + 10) 32.49, without ITD 19.47 (p < 0.001). Change in mean ETCO2 from (X) to (X + 10) with ITD + 4.19, without ITD, -5.88 (p = 0.003). The mean time from dispatch to (X + 10) with ITD was 20 min 30 sec, without ITD was 20 min 3 sec. ROSC with ITD 42.7%, without ITD 33.3% (p = 0.312). **Conclusion:** Use of an ITD resulted in statistically significant increased ETCO2 during resuscitation. ETCO2 is both a measurement of perfusion and ventilation. The group without the ITD had a slightly increased ventilation rate but a proportionately decreased ventilation duration most likely resulting in equal minute ventilation. The ITD reduces passive ventilation; it is not likely that passive ventilation exceeds physiologic dead space during cardiac arrest. The study was not powered to examine survival outcomes. However there was a trend to increased ROSC in the ITD group. In a system using mmicpr with controlled rate use of an ITD resulted in increased ETCO2 as a surrogate marker of perfusion.

126. SURVIVAL AND GOOD NEUROLOGIC OUTCOME FOLLOWING RESUSCITATION FROM CARDIAC ARREST DO NOT DIFFER BETWEEN NURSING HOME AND COMMUNITY DWELLERS

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Background: Survival following resuscitation from cardiac arrest may differ between nursing home (NH) residents compared to those living in the community. **Objectives:** We hypothesized that post-arrest mortality in NH patients would be higher and functional outcomes worse compared to community arrests. **Methods:** This study was approved by the University of Pittsburgh IRB. We reviewed all out-of-hospital cardiac arrests surviving at least 6 hours after tertiary care center arrival between 1/1/2010 and 6/30/2015. Of the 817 subjects, 48 NH subjects were matched 1:1 to a community arrest subject on gender, age (closest), initial rhythm (shockable vs. nonshockable), and illness severity (Pittsburgh Cardiac Arrest Category [PCAC]). Chi-squared analyses were used to compare groups. The primary outcome was survival to hospital discharge. Secondary outcomes were good neurologic outcome (defined as Cerebral Performance Category = 1/2 or modified Rankin Scale ≤ 2) and etiology of death (classified as hemodynamic instability; brain death; withdrawal for anticipated poor neurologic recovery; and withdrawal for non-neurologic reasons). **Results:** Mean age was 67 years (SD 15) in both cohorts. Most (62%) subjects were female and only 10% had shockable rhythms. All NH subjects were successfully matched to a community subject. Survival did not differ between cohorts (11/48 [23%] NH, 12/48 [25%]

community, p = 0.8). Only one NH subject had a good neurologic outcome. Care was withdrawn for non-neurological considerations in 7 (15%) of the NH subjects and no community subjects. **Conclusion:** In this matched cohort of hospital cardiac arrest subjects, survival to discharge and good neurologic outcome did not differ between NH subjects and community dwellers. Initial illness severity (PCAC) and primary rhythm may be more prognostic than NH status.

127. THE EFFECT OF POISONING AGENT ON OUTCOMES AFTER OUT-OF-HOSPITAL CARDIAC ARREST

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Background: Poisoning is the 4th leading contributor among non-cardiac out-of-hospital cardiac arrest (OHCA). **Objectives:** This study aimed to test the association between poisoning agent and outcomes after poisoning-associated OHCA. **Methods:** All poisoning-associated OHCA (P-OHCAs) were analyzed from a national registry for 2008-13 in Korea, excluding patients not-treated, without information on poisoning agent and hospital outcomes. Exposure was the poisoning agent group: group 1 (medically prescribed drug), group 2 (alcohol, solvent, and chemical), group 3 (gaseous agent), group 4 (pesticides/herbicides), and group 5 (other specified). Main outcomes were good neurological recovery measured with cerebral performance scale (1 and 2) and survival to discharge. Potential risk factors (age, gender, metropolis, place, witness, bystander resuscitation, response time interval, transport time interval, level of emergency department) were adjusted in the multivariable logistic regression model for main outcomes to calculate the adjusted odds ratios (AOR) and 95% confidence intervals (95% CIs). **Results:** Of 139,848 OHCAs (2008-13), a total 2,083 of P-OHCA was finally analyzed excluding patients of 360 not-treated and 1 patient with an unknown outcome. The survival to discharge and good brain recovery was 3.3% and 1.3%, respectively. Survival to discharge and good neurological recovery were 10.3%/ 5.6% (group 1, among n = 214), 2.2%/1.0% (group 2, among n = 492), 2.4%/0.4% (group 3, among n = 1,102), 6.9%/0.1% (group 4, among n = 29), and 3.3%/2.4% (group 5, among n = 246), respectively. AORs (95% CIs) for survival to discharge compared with group 1 were 0.334 (0.144-0.774) in group 2; 0.343 (0.174-0.676) in group 3; 0.474 (0.090-2.509) in group 4; and 0.311 (0.125-0.771) in group 5, respectively. AORs (95% CIs) for good neurological recovery compared with group 1 were 0.289 (0.083-1.001) in group 2; 0.072 (0.020-0.256) in group 3; 0.440 (0.044-4.352) in group 4; and 0.344 (0.111-1.060) in group 5, respectively. **Conclusion:** Prescribed drug group-induced OHCA showed significantly better survival to discharge and good neurological recovery than OHCA associated with chemical agents, gaseous agents, agricultural agents, and other specified agent groups.

128. ASSOCIATIONS BETWEEN GENDER AND CARDIAC ARREST OUTCOMES IN PAN-ASIAN OUT-OF-HOSPITAL CARDIAC ARREST PATIENTS

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Background: The incidence of out-of hospital cardiac arrest (OHCA) in women was known to be lower than that of men. Although more

studies have shown a positive influence of female gender on cardiac arrest outcomes, some study findings were inconsistent and unclear. **Objectives:** This study aimed to investigate the effect of gender on OHCA outcomes in the Pan-Asian population. **Methods:** This was a retrospective, secondary analysis of OHCA collected from Pan-Asian Resuscitation Outcomes Study (PAROS) between 2009 and 2012. We included OHCA cases which were presumed cardiac etiology, aged 18 years and above and resuscitation attempted by EMS. We used multi-level mixed-effects logistic regression models to account for the clustering effect of individuals within the country. Primary outcome was survival to hospital discharge (discharged alive/ remained in hospital at 30th day post-arrest). Secondary outcomes were return of spontaneous circulation (ROSC) at scene or emergency department (ED), survival until hospital admission and post-arrest overall and cerebral performance outcomes. **Results:** We included a total of 40,159 OHCA cases with a prevalence of around 60% in men and 40% in women. The univariate analysis showed women were significantly less likely to have ROSC at scene or ED, survival-to-admission, discharge and good overall and cerebral performance outcomes. The multivariate analyses reported no significant gender difference on outcomes. We found women in the reproductive age group (age 18–44 years) were significantly more likely to have ROSC at scene or ED, survival until admission and discharge and have good overall and cerebral performance outcomes after adjustment for differences in prehospital factors. Menopausal women (age 55 years and above) were less likely to survive on hospital admission after adjusting for baseline and prehospital characteristics (Odds ratio, 95% confidence interval; 0.8, 0.7–0.91). **Conclusion:** This multi-ethnic Asian population study showed women were more likely to have poor survival and neurological outcomes after OHCA. Differences in survival outcomes between reproductive and menopausal women age groups would highlight a need for further investigations into the plausible social, pathologic or hormonal basis for the relationship found.

129. EVALUATION OF APPROXIMATE ENTROPY AS A CPR QUALITY MEASURE

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Background: Standard cardiopulmonary resuscitation (CPR) quality metrics are based on univariate, linear measures of CPR process. Non-linear measures, such as approximate entropy (ApEn), which characterizes the disorder of a signal, have been utilized elsewhere (e.g., heart rate analysis), to capture phenomena eluding standard linear measures. **Objectives:** Preliminarily evaluate performance of ApEn as a CPR-quality metric. **Methods:** Case data for non-traumatic, EMS-treated out-of-hospital cardiac arrests were obtained from the Pittsburgh site of the Resuscitation Outcomes Consortium for the period spanning the years 2010 to 2014. Cases with at least 1 available defibrillator data file containing chest compression (CC) depth channels were included. CC depth data traces were extracted with MATLAB (2014b, The Mathworks, Natick, MA). CC for each available file were detected and used to calculate CC depth (mm), rate (compressions/minute), and flow fraction time series, which were reported in averages over 1-min epochs. Data from cases with multiple data files were merged. ApEn was calculated for each 1-min epoch of depth and rate. Correlation coefficients

were calculated to assess the relationship between ApEn, CC rate, CC depth, and flow fraction overall and stratified by pre/post 5 min of CPR. **Results:** Of a total of 1,278 cases with defibrillator downloads, a subset of 1,266 cases had analyzable CC depth channels. A total of 1,875,209 individual CC were detected and analyzed, covering 18,719 min of CPR. The overall mean (SD) for CC depth was 44.3 (11.0), for CC rate was 109.6 (11.0), and for flow fraction was 0.81 (0.20). Mean (SD) ApEn of CC rate was 0.92 (0.34) and of CC depth was 0.79 (0.23). ApEn of CC depth was weakly correlated with flow fraction ($r = 0.22$) and ApEn of CC rate ($r = 0.27$), but not CC rate or CC depth. Both before and after the 5-min mark, ApEn correlated weakly with flow fraction ($r = 0.14$ vs. $r = 0.24$) and ApEn of CC rate ($r = 0.30$ vs. 0.26). **Conclusion:** ApEn weakly correlated with CC flow fraction, a common CPR quality measurement. ApEn of rate and depth were not correlated with magnitude of CC rate or depth.

130. LONGITUDINAL STUDY OF BYSTANDER CPR RATES AND SOCIOECONOMIC STATUS

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Background: Multiple studies have stressed the importance of bystander CPR (BCPR) in out-of-hospital cardiac arrest (OHCA). Previous studies have shown that rates of BCPR in OHCA are positively correlated with the socioeconomic status (SES) of the location in which the event occurred. **Objectives:** We hypothesized that rates of BCPR in witnessed OHCA have increased in Pittsburgh, PA over the past 9 years due to CPR education efforts, and that BCPR rates in areas of high SES have increased faster than rates in areas of low SES. **Methods:** We used preexisting data from the Resuscitation Outcomes Consortium to examine cases of OHCA occurring in Pittsburgh, PA from 2006–14. Inclusion criteria: non-traumatic cardiac arrest; witnessed by a bystander and not by on-duty healthcare providers; treated by EMS; status of BCPR was determinable; and SES indicators were available for the event location. We used the 2013 census data to determine the median household income (MHI) and high school graduation rate (HSGR) for each census tract, which we used as a determinant of SES. The tracts were organized by tertile based on MHI and by tertile based on HSGR. We used STATA to perform generalized estimating equations on subject-level data. **Results:** There were 6,909 non-traumatic cardiac arrests during our study period, 3,510 were treated by EMS and 720 of these met our inclusion criteria. Controlling for age and sex, higher MHI increased odds of receiving BCPR (OR = 1.33, CI95:1.05–1.68, $p = 0.02$). Controlling for age and sex, higher HSGR increased odds of receiving BCPR (OR = 1.44, CI95:1.13–1.69, $p = 0.00$). Controlling for age and sex, the odds of receiving BCPR increased over time (OR = 1.08, CI95:1.00–1.16, $p = 0.04$). **Conclusion:** Our study supports previous studies showing that OHCA occurring in areas of high SES have a higher proportion of BCPR than those occurring in areas of low SES. Our study also showed an increase in rates of BCPR over time. We were unable to determine whether rates of BCPR increased at a faster rate in areas of high SES compared to low SES.

131. INCIDENCE AND OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST IN SCHOOL IN KOREA

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Background: Schools are one of the important locations for improving OHCA outcome by public advertisement, CPR education, or AED. But there is insufficient epidemiological data about OHCA in schools. **Objectives:** In this study, we aimed to show incidence and outcome of OHCA in schools. **Methods:** We used a nationwide, population-based OHCA registry from 2008 to 2013 in Korea. Presumed cardiac origin arrests that occurred in schools were included. OHCA were categorized as student, faculty, or visitors. The average annual incidence of OHCA in schools was calculated based on per 100,000 persons or per 1,000 schools for student, faculty, and/or visitors. **Results:** During the study period, 402 OHCA occurred in schools. Among them, 318 cases (79.1%) were presumed cardiac origin. Overall, the annual incidence was 52.1 (45.3–62.1) in non-students. Witnessed OHCA involving students were more common (80.8% vs. 66.5%), given more bystander CPR (33.1% vs. 17.0%), had more shockable rhythms (30.8% vs. 26.6%) when compared to the OHCA involving non-students. Twenty-four OHCA among students (18.5%) occurred during sports activity. Among non-student OHCA, 88 (46.8%) occurred during sports activity. The median (Q1–Q3) BLS response was 6 (5–8) in students and 6 (4–8) among non-students. The proportion of OHCA involving survival to hospital discharge was 38.5% ($n = 50$) among students vs. 31.4% ($n = 59$) in the non-student group. But the non-student group had better neurological outcome (CPC 1–2) of 28 (14.9%) compared to 13 (10.0%) in student group. **Conclusion:** Overall incidence of OHCA in school is low. About 40% of victims were visitors. One third of OHCA occurred during sports activity and these had higher incidence of shockable rhythm. The school AED program can be improved based on these findings.

132. THE IMPACT OF PREHOSPITAL CARDIAC CATHETERIZATION LABORATORY ACTIVATION ON SURVIVAL FROM WITNESSED OUT-OF-HOSPITAL SHOCKABLE CARDIAC ARREST

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Background: Prehospital cardiac catheterization lab activation has become a standard practice for patients experiencing ST-elevation myocardial infarctions (STEMI). Witnessed out-of-hospital shockable cardiac arrest is frequently the result of the same pathologic process. Bystander witnessed out-of-hospital cardiac arrest (OHCA) patients found in an initially shockable rhythm represent a subset of OHCA patients with a high likelihood of survival. **Methods:** On February 1, 2015, our EMS system, in cooperation with our hospitals and cardiology groups, adopted a protocol that would treat all adult patients with witnessed OHCA found in an initially shockable rhythm as STEMI equivalent patients. Prehospital providers were directed to promptly activate the hospital's cardiac catheterization lab team by declaring a "Cardiac Alert" from the field. Prehospital providers were directed to declare the "Cardiac Alert" prior to patient transport regardless of whether the patient had achieved a return of spontaneous circulation (ROSC) at

the time of cardiac catheterization lab activation. Unless the patient had a ROSC, a mechanical chest compression device, vascular access, and advanced airway were to be in place prior to patient movement and transport. We compared our Utstein survival, bystander witnessed OHCA in an initially shockable rhythm, during the 16 mon before our protocol change with our Utstein survival during the 6 mon after our protocol change. **Results:** During the 16 mon prior to our protocol change, there were 21 patients with bystander witnessed OHCA found in an initially shockable rhythm. Five of those patients survived to discharge from the hospital, 5 of 21 (24%), four of whom were neurologically intact, 4 of 21 (19%), defined as a Cerebral Performance Category (CPC) score of 1 or 2. During the 6 mon after our protocol change, there were 11 patients with bystander witnessed OHCA found in an initially shockable rhythm. Eight of these patients survived to discharge from the hospital, 8 of 11 (73%), all of whom were neurologically intact. Using chi-squared testing, differences in both overall and neurologically intact survival are significant ($p < 0.01$). **Conclusion:** Instituting a prehospital cardiac catheterization laboratory activation protocol for all adult patients with witnessed, shockable cardiac arrest improved overall and neurologically intact survival.

133. A CASE SERIES OF DOUBLE DEFIBRILLATION: IS THE HOLY GRAIL OF RESUSCITATION WITHIN REACH?

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Background: There is minimal evidence and data supporting the most effective method for defibrillation energy level or optimum pad placement. Double Sequence Defibrillation or Double Simultaneous Defibrillation (DSD) is the use of two defibrillators simultaneously at their highest allowed energy setting to treat refractory ventricular fibrillation (RVF). **Objectives:** We describe a case series of eight patients who received DSD. We hypothesized that early DSD would result in significant VF conversion. **Methods:** A retrospective case series was performed of all patients who received greater than 360 joules from January 1, 2015 to April 30, 2015. Additionally, physicians in an Emergency Department were also requested to provide data for any DSD during this time period. Seven cases of DSD were performed in the prehospital setting and one case was in the hospital setting during the 4-mon time period. **Results:** From 01/01/2015 to 4/01/2015, eight patients were treated with DSD. The median age was 61 (IQR: 45–78), with median resuscitation time of 31.3 min prior to the first DSD (IQR: 10–48). The median number of single shocks was 5.1 prior to DSD (IQR: 3–9), with a median of 2 (IQR: 1–3) DSED shocks delivered. VF converted after DSD in 5 cases (62.5%). Four patients survived to admission (50%). Three patients survived to discharge with no or minimal neurologic disability (37.5%). **Conclusion:** The correct amount of energy in joules for VF remains elusive. In pediatrics, patients receive VF defibrillation based on weight, yet adult defibrillation is based on a standard amount of energy. In our case series all but one of our survivors, DSD was performed within 26 min. A previous case series had less ROSC and survival but longer time period before DSD was performed. We hypothesize that earlier DSD based on double 360 joules and an additional defibrillation vector may result in improved ROSC rates and survival to discharge in VF arrests. Additional research is being conducted and routine DSD is being performed after three refractory attempts

at VF conversion. References available upon request.

134. THE EFFECTIVE USE OF SIMULATION TRAINING FOR "PIT CREW" CARDIOPULMONARY RESUSCITATION IMPLEMENTATION IN A LARGE, FIRE-BASED EMERGENCY MEDICAL SERVICES SYSTEM

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Background: Several challenges exist when implementing "pit crew" cardiopulmonary resuscitation (CPR) in large prehospital systems. Efficient training of prehospital providers is curtailed by other responsibilities and duties. **Objectives:** The objective of this study was to describe the effectiveness of simulation training for "pit crew" CPR implementation in a large, fire-based emergency medical services (EMS) system. **Methods:** This was a retrospective study conducted in a hospital-based simulation center between June 2014 and March 2015. "Pit crew" training sessions were targeted to EMS crews composed of emergency medical technicians (EMTs) and paramedics. The sessions consisted of three parts: an initial cardiac arrest simulation before "pit crew" CPR instruction (15 min), "pit crew" CPR instruction (30 min), and another cardiac arrest simulation after "pit crew" CPR instruction (15 min). The number of EMS personnel involved in each session ranged from five to seven. The primary outcomes were chest compression rate, chest compression depth and chest compression fraction. Inclusion criteria were all practicing EMTs and paramedics in the prehospital system. Providers were excluded if they were not clinically active. Descriptive statistics were reported as medians and interquartile ranges (IQR). The Mann-Whitney U test was used for significant testing ($p < 0.05$). **Results:** 474 paramedics participated in the simulation sessions. There was no difference in chest compression rate before and after "pit crew" training (pre-training: 125 compressions per minute, IQR 115–132; post-training: 123 compressions per minute, IQR 110–130; $p = 0.19$). Chest compression depth (pre-training: 1.79 inches, IQR 1.57–1.97; post-training: 1.92 inches, IQR: 1.65–2.16; $p = 0.03$) and chest compression fraction (pre-training: 77%, IQR 70–83%; post-training: 86%, IQR 83–90%; $p = 0.00$) increased following training. **Conclusion:** Improved chest compression depth and chest compression fraction were observed in EMS providers subjected to "pit crew" CPR simulation training; however, chest compression rate did not improve post-training. This study suggests that simulation training can be an effective means for "pit crew" CPR training in a large prehospital system with several logistical challenges to training and implementation. Further evaluation will be needed to determine long-term retention of "pit crew" CPR skills and effect on clinical outcomes.

135. WHAT REALLY INTERRUPTS CARDIOPULMONARY RESUSCITATION IN AN OUT-OF-HOSPITAL CARDIAC ARREST?

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Background: Cardiac arrest is one of the leading causes of death with over 300,000 deaths annually in the U.S. While 24% of In Hospital Cardiac Arrest (IHCA) patients survive, only 10% of Out-of-hospital Cardiac Arrest (OHCA) patients survive to discharge. Compression fraction during IHCA resuscitation is commonly above 80% and has

been correlated with increased survival. In OHCA, compression fraction is believed to be as low as 50%. **Objectives:** This study seeks to determine the accuracy of prehospital crew documentation and estimating timing of interruptions in CPR vs. that of trained observers in simulated OHCA scenarios. **Methods:** Observers underwent training to accurately document all interventions during OHCA resuscitation. This proof of concept study with simulated scenarios was used to compare the accuracy of direct observation with retrospective surveying of paramedics. The main outcome measures: ongoing interventions, compression fraction, length and cause of CPR interruption. Observers documented interventions and CPR interruptions in real time then asked paramedics to document their care and estimate the interruption time retrospectively. The actual timing of the interventions was determined through video analysis. Percent error in interruption time will be used to compare the accuracy in both types of data collection. A two-tailed T-test was used to determine any significant difference in percent error between the two groups. **Results:** This study found that retrospective surveying of paramedics led to a 33% error in recorded interruption time while direct observation led to a 6.8% error, a difference of 26.4% (95% CI 10.3–42.4). This difference was found to be statistically significant with a p-value of 0.0066. Also it was determined that direct observation led to a 1.5% error in the recorded order of events, while the retrospective surveying of paramedics led to a 34.8% error, giving a difference of 33.3%. **Conclusion:** This proof of concept study has shown that direct observation leads to a 26.4% (CI 10.3–42.4) reduction in error when documenting interruption time and a 33.3% reduction in error in the documented order of events during resuscitation. This initial data suggests that direct observation could lead to more accurate data collection than retrospective chart review alone.

136. THE OPTIMAL CHEST COMPRESSION RATE DEPENDS ON DURATION OF CPR AND WHICH PHYSIOLOGIC SIGNAL IS BEING MEASURED

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Background: Pre-clinical studies suggest that CPR can be personalized using coronary perfusion pressure (CPP) or end tidal carbon dioxide (ETCO₂) to titrate the optimal chest compression (CC) depth. **Objectives:** We studied the interaction between CC rate, CPR duration, blood flow, CPP, and ETCO₂ in fixed-depth CC. **Methods:** CPR was performed on nine domestic swine (~30 kg) using standard physiological monitoring. Flow was measured in the abdominal aorta, the inferior vena cava (IVC), the right renal artery and vein, the right common carotid and external jugular. Ventricular fibrillation (VF) was electrically induced. Mechanical CC were started after 10 min of VF. CC were delivered at a rate of 50, 75, 100, 125, or 150 compressions per minute (cpm) and at a depth of 2" for a total of 54 min. CC rates were changed every 2 min and were randomized. **Results:** In the first 10 min of CPR, ETCO₂ was largest at 150 cpm (49.2 ± 14.2 mmHg) and significantly ($p = 20$ min), CC efficacy decreased and most blood flows and pressures were optimized by rates of 100 cpm or less. **Conclusion:** The optimal CC rate during CPR changes as a function of time and varies for different physiologic metrics. This suggests that a fixed CC rate may not be optimal. Further work is needed to determine which physiologic measures might best relate to improved outcomes.

137. INTERRUPTIONS IN CARDIOPULMONARY RESUSCITATION WITH PLACEMENT OF A MECHANICAL CHEST COMPRESSION DEVICE

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Background: Optimal survival from cardiac arrest is associated with the percentage of time during cardiopulmonary resuscitation (CPR) in which continuous chest compressions are performed without interruption (chest compression fraction or CCF). **Objectives:** The purpose of this study is to determine the duration of chest compression pauses associated with placement of a mechanical chest compression device (LUCAS-2) in an urban 9-1-1 emergency medical services system (EMS). **Methods:** Retrospective review of consecutive 9-1-1 patients in out-of-hospital cardiac arrest (OOHCA) upon whom resuscitation was attempted, for the period between May-July 2015. Inclusion criteria: All cases of OOHCA where chest compressions were performed. Exclusion criteria: All cases where either a mechanical chest compression device was not applied or where data was unavailable for retrospective review. Manual chest compressions were identified by rhythmic waveforms transmitted through an electronic feedback device applied directly to the patient's chest during resuscitation (qCPR). Mechanical chest compression waveforms were detected by the bioimpedance channel (patient contact indicator or PCI channel) of the cardiac monitor used for rhythm monitoring during resuscitation. Initiation of mechanical chest compression was detected by the loss of waveforms detected by the qCPR device, but with the presence of waveforms detected on the PCI channel. Compression pauses were identified by the presence of a flat-line waveform on both the qCPR and PCI channels between termination of manual compression and initiation of mechanical compression. **Results:** 168 patients met inclusion criteria for the study. The LUCAS device was applied in 46 (27%) of cases, and data was not available for review in 62 (36%) of cases. The median duration of CPR interruption associated with application of the LUCAS mechanical compression device was 17 sec (interquartile range 11 to 26 seconds, range 4 to 75 sec), while 78% of mechanical compression device placements exceeded 10 sec. **Conclusion:** Placement of a mechanical compression device in the prehospital environment may be associated with prolonged pauses in chest compression. The presence of such pauses may have implications for survival from OOHCA.

138. THE GEOGRAPHY OF SUDDEN CARDIAC ARREST IN DETROIT

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Background: Bystander CPR is the key to improving cardiac arrest survival. Many large urban systems have reported very low bystander CPR rates. Recent national efforts present a strong emphasis on continuous collection and analysis of data through cardiac arrest registries at the EMS level. **Objectives:** Use registry data and geographic mapping data to assess bystander CPR rate by census tract with the longer term goal of targeting interventions to specific areas to improve bystander CPR rate. **Methods:** Utilizing the Cardiac Arrest Registry to Enhance Survival (CARES) and resources through the American Heart Association (AHA), data from August 2013 through April 2014 were analyzed to assess the incidence of cardiac arrest within the City of Detroit, as well as the bystander CPR rate. De-

mographic data of cases was then geo-mapped into the US Census tracts. **Results:** Within the City of Detroit, incidence of out-of-hospital sudden cardiac arrest during this time frame was 5.15 per 10,000 citizens. Bystander CPR rate was 16.4%. The national bystander CPR rate at this time was 40.8%. When individual cases are mapped by census tract, we are able to identify specific neighborhoods as high-risk and intermediate-risk for poor outcomes. "High risk" refers to both a higher than average incidence of SCA (for the City of Detroit) and lower than Detroit's average bystander CPR rate. "Intermediate" risk refers to locations with higher than average incidence of SCA with bystander CPR rates greater than the city's average but less than the national average. **Conclusion:** Identification of these high-risk neighborhoods can lead to targeted educational efforts for the citizens most at risk of a poor outcome. Community-based resources (schools, places of worship and community centers, for example) can now be identified within any given high-risk neighborhood to assist in such efforts.

139. REFRACTORY VENTRICULAR FIBRILLATION IN OUT-OF-HOSPITAL CARDIAC ARREST TREATED WITH DOUBLE SEQUENTIAL DEFIBRILLATION

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Background: The use of double sequential defibrillation (DSD) in the treatment of out-of-hospital cardiac arrest (OHCA) patients with refractory ventricular fibrillation (RVF) is not well studied. The benefit of prehospital use of DSD is unclear. **Objectives:** The objective of this case series was to describe the outcomes of patients treated with DSD for RVF in the prehospital setting. **Methods:** This was a retrospective evaluation of cardiac arrest events in a fire-based emergency medical services (EMS) system between August 1, 2010 and June 30, 2014. Inclusion criteria were all OHCA patients treated with DSD. RVF was defined as ventricular fibrillation refractory to five single defibrillations. Descriptive statistics were reported as medians and interquartile ranges (IQR). Neurological outcome was described using the Cerebral Performance Category (CPC) scoring system. **Results:** During the study period 2,407 patients were treated for OHCA, with 12 patients treated with DSD. Eleven patients (92%) were male with a median age of 54 (IQR 47.5-68.5). The median total resuscitation time was 39.5 min (IQR 31-42.5). Six (50%) were witnessed arrests, 7 (85%) received bystander cardiopulmonary resuscitation (CPR), and 2 (17%) received defibrillation with an automated external defibrillator (AED) prior to EMS arrival. The initial rhythm was ventricular fibrillation (VF) in 11 patients (92%) with one patient presenting in pulseless electrical activity (PEA). The median number of single defibrillations was 5 (IQR 5-6), and the median number of DSD was 2 (IQR 1-2). The median time to DSD was 27 min (IQR 22-33). DSD broke ventricular fibrillation in 9 patients (75%) with 3 patients (25%) achieving prehospital return of spontaneous circulation (ROSC), and 3 patients (25%) surviving to hospital discharge. Of the survivors, 2 patients (67%) had a CPC score of 1 at discharge. **Conclusion:** In this evaluation, the use of DSD resulted in the conversion of RVF in 75% of treated patients. All patients with ROSC survived to hospital discharge and 67% had normal CPC scores. The evaluation suggests that DSD may be a tool in the prehospital armamentarium to improve neurological survival from OHCA. Larger studies are needed to further evaluate the efficacy of prehospital DSD for RVF.

140. TRANSITIONING FROM D2B (DOOR-TO-BALLOON) TIME INTERVAL DATA COLLECTION TO R2R (RECOGNITION-TO-REPERFUSION) TIME INTERVAL DATA COLLECTION TO CREATE, MONITOR, AND IMPROVE A STEMI SYSTEM OF CARE IN SOUTHEAST MICHIGAN

Luke Bowen, Antonio X. Bonfiglio, Dean Dalbec, Robert Dunne, Macomb County EMS Medical Control Authority

Background: The Macomb County Medical Control Authority (MCMCA) consists of 27 EMS agencies and 8 member-owned hospitals, of which 5 are STEMI receiving centers and 3 are STEMI referral centers. To create a "STEMI System of Care" it is necessary to expand time interval data collection from D2B (door-to-balloon) to R2R (recognition-to-reperfusion) to assess the partnership between prehospital and hospital stakeholders. **Objective:** Create a data monitoring tool to collect data which reflects critical time intervals beginning with EMS notification through reperfusion. A pre-determined goal of 60 min for D2B and 90 min for R2R was established based upon the American Heart Association "Mission Lifeline[®]" recommendations for an ideal "STEMI System of Care." **Methods:** A retrospective, observational data collection began in January 2013 and continued through December 2014. A data collection matrix captured the following time elements from which critical time intervals were computed: EMS notified to EMS arrival (EMS response time); EMS arrival to 12-lead ECG transmission (EMS 12-lead acquisition/transmission time); EMS notified to arrival in ED (total EMS time); ED arrival to 1st hospital ECG (1st hospital ECG time); ED arrival to cath lab activation (cath lab activation time); ED arrival to reperfusion (D2B time); EMS notified to reperfusion (R2R time). **Results:** Each of the 5 STEMI receiving centers data was submitted to the MCMCA by the ED EMS Coordinator. In 2013 a total of 181 patients were identified with an average R2R time of 83.9 min. 2014 data identified 168 patients with an average R2R time of 84.9 min. **Conclusion:** 2013 and 2014 time data is within the goal of R2R of 90 min or less. As a STEMI System of Care, monitoring the R2R time interval provides a critical loop closure to the EMS agencies and PCI centers to identify areas for improvement. The study identified limited areas for time interval reduction in the prehospital setting (e.g., time to 12-lead ECG acquisition/transmission). Multiple opportunities for time interval reduction were identified in the in-hospital setting (e.g., time to 1st ECG, time to activate cath lab) and total hospital process time (D2B).

141. DOMAINS OF AGREEMENT OF NIHSS SCORING BETWEEN HELICOPTER EMS, ICU NURSES, AND NEUROLOGISTS

Denisse J. Sequeira, Lori Shutter, Christian Martin-Gill, Francis X. Guyette, University of Pittsburgh Department of Emergency Medicine

Background: Stroke is a major cause of death and disability. Most stroke patients access the medical system through Emergency Medical Services (EMS). The availability of time dependent therapies for stroke makes accurate triage critical. Prehospital notification by EMS reduces delay in stroke evaluations. We previously demonstrated that there is moderate to good agreement between helicopter emergency medical services (HEMS) crews and neurologists using the National Institutes of Health Stroke Scale (NIHSS) to identify large vessel occlusions (LVO) but the NIHSS is difficult to teach and maintain competency. **Objectives:** We aim to describe the domains of agreement between HEMS providers, intensive care unit

(ICU) nurses and neurologists in administering the NIHSS. **Methods:** We reviewed 358 patients transported by a critical care transport system to a comprehensive stroke center in 2014. Inclusion required a final diagnosis of ischemic stroke, and an NIHSS recorded by the HEMS crew, the ICU nursing staff and the neurologist. The prehospital NIHSS were obtained from emsCharts (Warrendale, PA), whereas the initial nurse and neurologist NIHSS were obtained from in-hospital records (Cerner, Kansas City, MO). The scores were analyzed in pairs as HEMS-neurologist (H-Ne), nurse-neurologist (Nu-Ne), and HEMS-nurse (H-Nu). We used a weighted kappa statistic to analyze the inter-rater agreement of the NIHSS and its individual domain scores. **Results:** Total NIHSS score showed moderate agreement between Nu-Ne ($k = 0.71$), H-Ne ($k = 0.66$), and Nu-H ($k = 0.62$). Between all three pairs, agreement for limb ataxia was poor (H-Ne $k = 0.02$, Nu-Ne $k = 0.06$, H-Nu $k = 0.07$) and sensory loss was fair (H-Ne $k = 0.37$, Nu-Ne $k = 0.34$, H-Nu $k = 0.28$). H-Ne additionally showed only fair agreement in terms of the visual fields ($k = 0.29$), dysarthria ($k = 0.31$) and extinction/inattention ($k = 0.25$). **Conclusion:** HEMS scored the total NIHSS with moderate agreement when compared with neurologists and nurses. We identified only fair or poor agreement among the individual domains of limb ataxia and sensory between all raters. Visual fields, dysarthria, and extinction/inattention demonstrated only fair agreement between HEMS and neurologists. These domains suggest a focus for improved education and training of providers.

142. ELECTROCARDIOGRAPHIC DIAGNOSIS OF ST SEGMENT ELEVATION MYOCARDIAL INFARCTION: AN EVALUATION OF SEVERAL AUTOMATED INTERPRETATION ALGORITHMS

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Background: The objective of this study was to assess the validity of three computerized electrocardiographic (ECG) interpretation algorithms with respect to the algorithms' ability to correctly identify STEMI patients in the prehospital setting who require emergent cardiac intervention. **Methods:** This retrospective study evaluated test performance characteristics of three ECG diagnostic algorithms with the intent to identify the presence of a culprit coronary artery (CCA) upon catheterization to diagnose STEMI. The study setting was a metropolitan EMS agency and an 850 bed urban, academic, cardiac intervention capable hospital. Paramedics analyzed prehospital ECGs for STEMI system activation according to local protocol. Data from this study were derived from patients transported between 1/1/2012–12/31/13. Two patient groups were enrolled: those with verified prehospital STEMI activation (cases) and those with a prehospital impression of chest pain potentially due to ACS (controls). Each patient's first interpretable 12-lead ECG was analyzed. A data file with blinded electronic prehospital ECGs was sent to the industry partner for testing against all three algorithms (AG1, AG2, AG3). Each algorithm evaluated the 12-lead ECG for pre-specified criteria to report the ">" diagnostic statement. Primary analysis assessed the validity of each algorithm by conducting an analysis of sensitivity, specificity, positive and negative likelihood ratios to detect a patient with a CCA; McNemar's chi square assessed for between algorithm differences in sensitivity

and specificity. **Results:** There were 500 patient records analyzed, resulting in a case group with 151 patients and a control group with 349 patients. Statistical differences in sensitivity to detect CCA were found when comparing AG1 to AG3 (0.69 vs. 0.62, $p = 0.0039$) and AG2 to AG3 (0.68 vs. 0.62, $p = 0.0027$). Specificity in detecting CCA also differed, with AG1 and AG2 significantly less specific than AG3 (0.89 vs. 0.95, $p = 0.0002$ and 0.91 vs. 0.95, $p = 0.0002$). **Conclusion:** Computerized ECG diagnostic algorithms can be designed to maximize sensitivity or specificity in detecting CCA. Individual applications may vary, and local needs could favor use of a higher sensitivity algorithm vs. a higher specificity algorithm. Future research should focus on optimizing computerized ECG algorithms for timely and accurate STEMI diagnosis.

143. FIREFIGHTER FIRST RESPONDER APPLICATION OF ECG ELECTRODES AND CABLES REDUCES TIME TO PREHOSPITAL ECG IN EMS PATIENTS

Jefferson G. Williams, Stephanie Trowbridge, Samuel A. Lazoff, Kevin C. Annis, Christopher M. Prevatte, Michael W. Bachman, Wake County Department of EMS

Background: EMS ECG acquisition and analysis is effective in improving process measures and outcomes in acute coronary syndrome (ACS) patients. Firefighter First Responders (FR) are the key members of EMS systems, and are often first on scene. **Objectives:** Our objective was to assess whether FR assistance with ECG acquisition improves time to ECG for EMS patients. We hypothesize that FR ECG acquisition will decrease time to ECG. **Methods:** We conducted a non-randomized interventional study of all EMS calls in which an ECG was obtained ("EMS ECG calls") in our third-service urban/suburban EMS system (pop 1,000,000) over a period of 3.5 mon. EMD-dispatched FR units from 22 departments supplement Advanced Life Support (ALS) ambulance response. One large municipal fire department was issued ECG electrodes and cables and received education regarding indications and technique for 12-lead ECG acquisition. For patients in whom an ECG was indicated, FRs placed the electrodes and cables prior to EMS arrival and then prompted acquisition of the ECG once the ALS ambulance arrived with the cardiac monitor. Data were abstracted retrospectively from patient care reports. Cases of FR assistance with ECG (FR ECG) were compared to concurrent controls (all other EMS ECG calls) using descriptive statistics and 95% confidence intervals. The primary outcome was time from EMS unit arrival to 12-lead acquisition. Cardiac arrest cases were excluded. **Results:** Of 5,290 eligible EMS ECG calls, 94 were FR ECG cases. Groups were demographically similar. The mean time to ECG (minutes) was 6.1 (95% CI 4.5–7.7) for FR ECGs vs. 12.5 (12.3–12.8) for all other ECGs. For EMS ECG calls in which a STEMI alert was initiated by EMS, mean time to ECG was 2.4 min (1.3–3.5) for FR ECGs ($n = 3$), vs. 6.9 min (5.3–8.6) for other ECGs ($n = 50$). Limitations include the small sample of STEMI patients. **Conclusion:** FR assistance decreased time to ECG by half, including patients concerning for ACS. As guidelines stress time-based process measures for ACS patients, we describe a novel approach to decreasing time to ECG in EMS patients. Further study should evaluate whether time to EMS ECG improves outcomes in ACS patients.

144. THE IMPACT OF RECOMMENDED PCI CARE ON HOSPITAL OUTCOMES FOR TRANSFERRED STEMI PATIENTS

Yeong Ho Choi, Yu Jin Lee, Sang Do Shin, Young Sun Ro, Kyoung Jun Song, Seoul National University

Background: AHA recommended that time from first medical contact to balloon should be within 120 min for transferred patients did not receive thrombolysis in primary hospital. **Objectives:** The aim of this study was to evaluate the impact of reperfusion strategy recommendation by AHA on hospital outcomes for STEMI patients. **Methods:** We used the CardioVascular disease Surveillance (CAVAS) data from November 2008 to December 2012. Eligibility was the adult patients who diagnosed for STEMI and transferred from primary hospital for definite PCI. The patients who received PCI or CABG in primary hospital and who arrived to primary hospital over 4 h from symptom, time from door to balloon over 24 h in definite hospital, and unknown ED disposition were excluded. Endpoint was hospital mortality. Main exposure was AHA recommendation for reperfusion therapy. We tested the association between compliance of recommendation (compliance vs. violence group) on hospital mortality. **Results:** Total of 1,799 patients were analyzed, 30.7% and 69.3% were in compliance and violence. Elderly was less in compliance (37.4%) than violence (47.9%) (p -value <0.01). EMS was used for 15.7% of compliance and 16.2% of violence (p -value = 0.80). Cardiogenic shock and arrest were 7.1% and 1.3% in compliance and 8.0% and 0.9% in violence, respectively. Hospital mortality was 4.5% and 7.2% in compliance and violence (p -value = 0.03). The crude odds ratio (95% CIs) of compliance group for hospital mortality was 0.61 (0.39–0.96) and adjusted odds ratio was 0.75 (0.46–1.21). **Conclusion:** In transferred STEMI patients, PCI care recommended by AHA was associated with lower mortality.

145. INTRAOSSEOUS PRESSURE MONITORING IN HEALTHY VOLUNTEERS

Joshua G. Salzman, Ralph J. Frascione, Abigail E. Zagar, Nicholas M. Loken, Aaron M. Burnett, Bjorn K. Peterson, Kent R. Griffith, Christopher Ward, Sandi S. Wewerka, Regions Hospital

Background: Intraosseous (IO) pressure monitoring has not been explored as a potential invasive monitoring option for critically ill and injured patients. **Objectives:** The objective of this study was to describe IO pressure measurements in normal healthy volunteers. **Methods:** This is a prospective, proof of concept, pilot study of healthy volunteers approved by our local institutional review board. Inclusion criteria included age 18–70 year old, BMI 19–40, ability to provide informed consent, and no active treatment for any disease. Participants consented to have two IOs placed per device manufacturer recommendations (tibial and humeral). External cuff pressure readings were recorded every 5 min, and IO pressure measurements were recorded continuously for up to 60 min. A safety review committee reviewed data after the 10th and 15 participants were enrolled. Mean IO pressure readings and systolic/diastolic cuff pressure measures were summarized and are reported descriptively. The slopes of mean IO pressure readings from the start to the end of the monitoring session are also described. **Results:** Fifteen patients were enrolled between April and July 2015. Average patient age was 33 years old (range = 22–50), and 40% were female. The IO waveform morphology was arterial, including a distinct dichrotic notch. Respiratory variability within the waveform tracing was also observed in all subjects. Results from the humeral placements were inconsistent and are not presented.

The median of the mean tibial IO pressure across the study sample was 60 mm Hg (IQR = 30.5–83.5 mm Hg). In the majority of participants, the mean tibial IO pressure was below the systolic and diastolic cuff readings. We observed a decrease in IO pressure from the initial placement until the final reading, with an approximate 1% decrease in pressure per minute. **Conclusion:** This is the first study in healthy volunteers establishing the presence of an intraosseous waveform, which was observed to be arterial in nature. The mean tibial IO pressure was consistently obtained but had a wide variation in absolute values. IO pressure decreased approximately 1% per minute during the testing period.

146. THE IMPACT OF URBANIZATION ON FIRST-DOOR-TO-BALLOON TIME DELAY IN ST-ELEVATION MYOCARDIAL INFARCTION PATIENTS UNDERGOING INTER-HOSPITAL TRANSFER

Ki Ok Ahn, Sang Do Shin, Won Chul Cha, Hyun Wook Ryoo, Young Sun Ro, Taeyun Kim, Seoul National University Hospital

Background: Inter-hospital transfer delays for ST-elevation myocardial infarction for primary percutaneous coronary intervention may be shortened by improved regional care systems. The urbanization level is among the main concerns for regionalization. **Objectives:** We evaluated the effect of the urbanization level on the transfer process and first door-to-balloon time in ST-elevation myocardial infarction patients who underwent inter-hospital transfer for primary percutaneous coronary intervention. **Methods and Results:** We evaluated the association between the first door-to-balloon time and urbanization level (metropolitan, urban, and rural) in 1,258 patients who underwent inter-hospital transfer for primary percutaneous coronary intervention from the Cardiovascular Disease Surveillance program in Korea. In rural areas, only 16.0% of patients had a first door-to-balloon time <120 min, recommended by the ACCF/AHA guidelines for the management of ST-elevation myocardial infarction (28.3% and 41.4% in urban and metropolitan areas, respectively; $P < 0.01$). Even after adjusting for potential confounders, rural areas were significantly associated with first door-to-balloon delays (adjusted odds ratio for total door-to-balloon time <120 min, 2.01, 95% confidence interval 1.40–2.19 vs. urban areas; 3.70, 95% confidence interval 2.59–5.38 vs. metropolitan areas). Each transfer process (length of stay in the referring hospital and inter-hospital transport time) was delayed compared with the counterparts in the urban and metropolitan areas ($P = 0.02$ and $P < 0.01$, respectively). **Conclusion:** Rural areas are the most vulnerable for transfer delays of ST-elevation myocardial infarction patients undergoing inter-hospital transfer for primary percutaneous coronary intervention. Different designs for regional network systems by urbanization level should be considered.

147. THE IMPACT OF RECOMMENDED PCI CARE ON HOSPITAL OUTCOMES FOR TRANSFERRED STEMI PATIENTS

Yeong Ho Choi, Yujin Lee, Sang Do Shin, Young Sun Ro, Kyoung Jun Song, Seoul National University Hospital

Background: AHA recommended that time from first medical contact to balloon should be within 120 minutes for transferred patients that did not receive thrombolysis in primary hospital. **Objectives:** The aim of this study was to evaluate the impact of reperfusion strategy recommendation by AHA on hospital outcomes for STEMI patients. **Methods:** We used the

CardioVascular disease Surveillance (CAVAS) data from Nov 2008 to Dec 2012. Eligibility was the adult patients who diagnosed for STEMI and transferred from primary hospital for definite PCI. The patients who received PCI or CABG in primary hospital and who arrived to primary hospital over 4 hours from symptom, time from door to balloon over 24 h in definite hospital, and unknown ED disposition were excluded. Endpoint was hospital mortality. Main exposure was AHA recommendation for reperfusion therapy. We tested the association between compliance of recommendation (compliance vs. violence group) on hospital mortality. **Results:** Total of 1,799 patients were analyzed, 30.7% and 69.3% were in compliance and violence. Elderly was less in compliance (37.4%) than violence (47.9%) (p -value < 0.01). EMS was used for 15.7% of compliance and 16.2% of violence (p -value = 0.80). Cardiogenic shock and arrest were 7.1% and 1.3% in compliance and 8.0% and 0.9% in violence, respectively. Hospital mortality was 4.5% and 7.2% in compliance and violence (p -value = 0.03). The crude odds ratio (95% CIs) of compliance group for hospital mortality was 0.61 (0.39–0.96) and adjusted odds ratio was 0.75 (0.46–1.21). **Conclusion:** In transferred STEMI patients, PCI care recommended by AHA was associated with lower mortality.

148. A DESCRIPTIVE ANALYSIS OF OCCUPATIONAL FATALITIES AMONG US POLICE OFFICERS DURING TACTICAL OPERATIONS OVER A 15-YEAR PERIOD

Matthew D. Sztajnkrycer, Moriah S. Thompson, Tyler M. Hartman, Mayo Clinic

Background: Minimal information is known about the nature of occupational fatalities amongst tactical officers. A greater understanding of the nature of such injuries is needed in order to improve officer safety. **Objectives:** The purpose of this study is to provide a descriptive analysis of line of duty deaths during tactical operations secondary to felonious assault. **Methods:** Retrospective analysis of open source de-identified Federal Bureau of Investigation (FBI) Uniform Crime Reporting (UCR) Law Enforcement Officers Killed and Assaulted (LEOKA) data inclusive of the years 1997–2013. Tactical operations were defined as assignment to a SWAT team, fugitive task force, or narcotics task force. **Results:** Of 906 officer deaths during the study period, 53 (5.8%) involved tactical officers. On average, officers were 36.8 years of age at the time of death with 11.3 years of law enforcement experience. High risk warrant service accounted for the largest number of fatalities (62.3%). A single officer was killed in 89.6% of events; 49.1% of cases involved injuries to other officers. The majority (62.3%) of officers killed were the first officer(s) to enter the scene. The most commonly identified cause of death was head trauma ($n = 20$). Chest trauma accounted for 14 deaths; ten (71.4%) sustained an entry wound via the ballistic vest armhole. The most common weapon types causing injury were pistols ($n = 29$) followed by assault rifles ($n = 14$). Where recorded, 52.2% of officers died within the first hour of injury. The provision or nature of buddy care, tactical EMS care, or conventional EMS care was rarely noted. **Conclusion:** Tactical officer deaths most commonly occur during high risk warrant service, and most often involve the first officer(s) to enter a scene, suggesting an opportunity for improved operational tactics. The frequency of fatal axillary penetration suggests the opportunity for ballistic protection redesign. Information is lacking regarding on-scene care, limiting the ability to determine optimal medical procedures for downed officers during tactical operations. However, nearly 50% of victim officers sur-

vived more than one hour from time of injury, suggesting opportunities to intervene and potentially affect outcomes.

149. COMPARISON OF AN I-GEL VS. KING AIRWAY IN A SIMULATED TACTICAL ENVIRONMENT

Juan A. March, Noel Resurreccion, Theresa Tassey, Roberto Portela, Bryan Kitch, East Carolina University

Background: In a tactical environment there are several emergent airway options available. One published manuscript suggests that use of the King LT laryngotracheal airway device (KA) is superior and minimizes exposure in a tactical environment when compared to endotracheal intubation (ETI). However, there is no published data comparing two different blind insertion supraglottic airway devices in a tactical environment. **Objectives:** This study compares the King laryngotracheal airway (KA) and I-Gel airway (IGA) in a tactical environment, to determine if one device is superior in minimizing exposure and time to tube placement. **Methods:** This prospective randomized trial was performed using the same methods employed in a previously published study which compared ETI vs KA in a tactical environment. The tactical environment was simulated using a 12 inch vertical barrier, which was used to simulate concealment, identical to the model from the previously published study. Participants included paramedic students who wore an Advanced Combat Helmet (ACH) and a soft armor vest (IIIA) without ballistic plates. The participants first practiced in full tactical gear with both the KA and IGA, and were randomized to determine which device they used first. We measured the time to tube placement in an airway manikin comparing the IGA and KA. During each airway attempt participants were videotaped to monitor maximum exposure, measured as height of the helmet above the 12-inch barrier. Data was analyzed using an ANOVA test. **Results:** A total of 19 paramedic students who were already at the basic EMT level participated. Time for tube placement of the KA was 39.7 sec (95%CI: 32.7–46.7) vs. 14.4 sec (95%CI: 12.0–16.9) for the IGA, $p < 0.001$. Maximum exposure as measured by the height of the helmet above the barrier for the KA was 1.42 inches (95%CI: 0.38–0.63) vs. 1.42 inches (95%CI: 0.32–0.74) for the IGA, $p = 0.99$. In addition, 100% of the participants preferred using the IGA device over the KA. **Conclusion:** In a simulated tactical environment, the IGA can be placed faster than the KA with a statistically significant time difference. There was no difference detected in the exposure of the practitioner between the two devices.

150. NAVY EN ROUTE CARE: A THREE YEAR REVIEW OF 428 NAVY AIR EVACUATIONS

Benjamin D. Walrath, Vik S. Sebarta, David Wampler, Victoria Ganem, Alejandra G. Mora, Elliot Ross, Stephen Harper, Chetan Kharod, Gerard Demers, United States Navy

Background: En Route Care (ERC) is not a program of record in the Navy. However, there is a recognized need to develop the capability of Navy ERC from the sea base as we prepare for future military and humanitarian operations. **Objectives:** Our objective was to report clinical ERC cases treated by Navy operational assets from January 2012–January 2015. **Methods:** This was a 3 year (1/2012–1/2015) retrospective analysis of prospectively collected SAR data obtained from The Search and Rescue Model Manager (SARMM) office. Data elements collected and analyzed include: total number of patients transported dichotomized for advanced life support (ALS) or basic life

support (BLS), time and duration of transport, and type of ERC provider. Descriptive data were reported as mean \pm SD (median [IQR]). Analysis utilized chi-square or Fisher's exact tests where appropriate. **Results:** During the period 428 patients were transported by Navy assets and reported to SARMM office. Transport time was 67 ± 65 ; (54[IQR 30-78]) min. Missions were staffed by 76% Search and Rescue Medical Technicians (SMT), 25% Flight Surgeons (FS), and 21% other. 22% of missions had a mix of providers. Patients were 75% male, 36 ± 20 (30[IQR 22-50]) years old, 47% military, and 48% trauma. A total of 54% were ALS transports; 47% were transported with an IV; 40% used supplemental oxygen; 13% had an airway device; 49% required cardiac monitoring; and 32% received medications. Medical patients were more likely to be ALS transports than trauma patients (61% vs. 46%, $p = 0.002$). FS were not associated with transport level or patient type. **Conclusion:** We found that the majority of patients transported by Navy ERC required at least ALS level of provider. Because future littoral combat may involve Navy ERC, it should be funded as a program of record to optimize the readiness of Navy Medicine to support the warfighter.

151. U.S. NAVY CORPSMEN RARELY EARN NATIONAL EMERGENCY MEDICAL TECHNICIAN CERTIFICATION

Stephen Harper, Remle Crowe, Melissa Bentley, Chetan Kharod, Benjamin D. Walrath, United States Army

Background: Navy Hospital Corpsmen (HMs) are the Navy equivalent to Emergency Medical Technicians (EMTs). In 2000, the Emergency Medical Services (EMS) Education Agenda for the Future highlighted the need for a single certification agency to provide consistent evaluation of entry level competence for EMS providers. In 2006, the Institute of Medicine concurred with this recommendation and further recommended that "states accept national certification as a prerequisite for state licensure..." Administered by the National Registry of EMTs (NREMT), National EMS Certification is currently utilized by 46 states, the District of Columbia, 4 territories, and 6 federal organizations as part of their processes for granting licensure. Unlike the Air Force (USAF) and Army (USA), the Navy (USN) does not require National EMS Certification. **Objectives:** Describe the number of USN HMs, USAF medics, and USA combat medics who have obtained National EMT Certification from 2007 to present. **Methods:** In order to obtain National EMT Certification, a candidate must successfully complete the computer adaptive cognitive exam and a psychomotor exam comprised of 5-10 state specific skills. Results from all USN HMs, USAF medics, and USA combat medics who tested between January 1, 2007 and December 31, 2014 were queried from the NREMT database. Descriptive statistics were calculated. **Results:** During the study period a total of 89,136 USN HMs (3.6%), USAF medics (18.1%), and USA combat medics (78.3%) became nationally certified at the EMT level. On average, 397 HMs obtained National EMT Certification each year over the past eight years. Over the same time frame, an average of 2,024 USAF medics and 8,720 USA combat medics obtained National EMT certification each year. In FY14, approximately 10,000 HMs graduated from the Department of Defense Medical Education and Training Campus at Joint Base San Antonio, Texas. **Conclusions:** In FY14, less than 4% of HMs obtained a nationally recognized standard for entry-level competence utilized by civilian EMTs and other branches of the military. A

policy that requires National EMS Certification will validate the HM training program and demonstrate that Navy prehospital providers possess the same knowledge and skills as their civilian and other service counterparts.

152. PREHOSPITAL VITAL SIGN MONITORING AND TRAUMATIC BRAIN INJURY: WHAT WE DON'T SEE COULD KILL YOU

Robyn McDannold, Melody Glenn, John Tobin, Mark Venuti, Annemarie Silver, Dan Spaite, Bentley Bobrow, University of Arizona

Background: Prehospital care significantly impacts traumatic brain injury (TBI) outcomes. Guidelines recommend q5' monitoring of vital signs (VS) for TBI patients, because a single event of hypoxemia, hypocapnia, and/or hypotension is associated with significant secondary brain injury. **Objectives:** The purpose of this study was to determine the impact of VS monitoring and documentation on the occurrence of hypotension, hypocapnia, and hypotension as well as to identify whether VS documentation differs by injury type. **Methods:** Prehospital patient care reports (PCRs) and monitor files were reviewed from 195 consecutive patients with suspected traumatic brain injury treated between 12/2012 and 3/2015 at 3 EMS agencies participating in a prehospital TBI quality improvement project aimed at implementing nationally-vetted TBI Guidelines in Arizona. One-way ANOVA and Kruskal-Wallis tests were used to determine whether VS's (SpO₂, ETCO₂, and SBP) recorded by the monitor differed between cases with and without PCR q5' VS documentation. **Results:** Of 202 TBI cases (mean age 42 yr, 69% male, initial GCS = 9.5 ± 4.1), VS documentation was not feasible for 8 cases ($n = 6$ cardiac arrest, $n = 2$ combative patients). Of the remaining 194 cases, complete VS were documented q5' in 41% of the cases. Hypocapnia (ETCO₂ < 35mmHg) was detected on monitor review more often in cases without q5' PCR VS documentation ($39.8\% \pm 43.6$ ETCO₂ readings < 35mmHg without q5' VS) vs. with q5' documentation ($26.3\% \pm 40.2$; $p = 0.03$). Similarly, hypotension (SBP < 90 mmHg or < 70 mmHg + 2age for pediatrics) was more common when q5' VS were not documented ($21.9\% \pm 13.2$ readings below SBP target) vs. with q5' documentation ($16.9\% \pm 10.3$, $p = 0.01$). Hypoxemia rates were similar for cases without ($14.1 \pm 24.3\%$ SpO₂ readings < 90%) vs. with q5' VS ($14.7\% \pm 27.1$, $p = 0.9$). VS documentation q5' was less common for TBI patients involved in motor vehicle crashes (18/63 = 29%) and assaults (7/19 = 37%) compared with isolated head trauma (3/7 = 57%), falls (38/77 = 49%), and unknown causes (13/28 = 42%). **Conclusion:** TBI patients are more likely to suffer hypotension and hypocapnia when VS are not documented every 5 min as recommended by the guidelines. Future studies are merited to determine whether hypotension and hypocapnia can be reduced with improved VS monitoring and documentation, especially in cases where patient monitoring and documentation are most challenging for prehospital providers.

153. EVALUATION OF THE EFFICACY OF THE iTCLAMP® FOR HASTY COMPRESSIBLE HEMORRHAGE CONTROL VS. A TOURNIQUET DURING "CARE UNDER FIRE"

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Background: Hemorrhage is the leading cause of preventable death on the battlefield.

During the last two conflicts the tourniquet has proven a lifesaving hemorrhage control device. Tourniquet use is associated with severe pain, transient impairment of limb function, and potential injury. The iTClamp® (Innovative Trauma Care, Inc.) is an FDA cleared device to stop hemorrhage by closing the soft tissue over a wound. If the iTClamp® is equivalent to a hasty tourniquet for hemorrhage control, it could become an option for prehospital tactical and non-tactical medical care. **Objectives:** This study compared the hemorrhage control characteristics of the iTClamp® and a tourniquet in an extremity with arterial hemorrhage. **Methods:** This was a randomized, balanced, two-period, two-sequence, two-treatment, crossover study. A comparably viscous, biochemically-inert, human blood analog was perfused (proximal infusion pressure of 92 mmHg) into fresh, human cadaver legs. Simulated arterial hemorrhages in the thigh and lower leg were studied separately on the same lower extremity. Perfusion controls were performed prior to the creation of surgical wounds in the femoral and posterior tibial artery. After a 2-mm incision was placed in the subject artery, the tourniquet and iTClamp® were applied per manufacturer recommendations, during separate randomized iterations. A 2-minute bleeding interval was used. Hemorrhage was classified as fluid lost from the intravascular space. Perfusion was defined as the amount of blood collected distal to the wound. Statistical testing was 2-sided with a significance level of 5%. **Results:** A total of 16 pairs of fresh, human cadaver legs were included. The mean intravascular fluid loss (hemorrhage), measured at the posterior tibial artery was greater with the clamp relative to the tourniquet [Clamp 120 ± 47 , Tourniquet 16 ± 14 , difference 104 ± 51 , $p < 0.001$] and femoral artery [Clamp 103 ± 68 , Tourniquet 5 ± 4 , difference 98 ± 70 , $p < 0.001$]. The clamp allowed more distal blood flow than the tourniquet within the thigh [Clamp 235 ± 12 , Tourniquet 11 ± 5 , difference 225 ± 12] and lower leg [Clamp 191 ± 10 , Tourniquet 18 ± 4 , difference 173 ± 12], whereas the post perfusion circumference was greater with the clamp than with the tourniquet at both the thigh [Clamp 1.1 ± 0.1 , Tourniquet 0.2 ± 0.1 , difference 0.9 ± 0.1] and lower leg [Clamp 1 ± 0.1 , Tourniquet 0.3 ± 0.1 , difference 0.8 ± 0.2]. **Conclusion:** In our non-coagulating cadaver model, the mean intravascular fluid loss, the mean fluid perfused distally, and the mean circumference change were all significantly increased with the iTClamp®.

154. ACUTE TRAUMATIC COAGULOPATHY ON THE CONTEMPORARY BATTLEFIELD: IMPACT OF TRAUMATIC BRAIN INJURY ON COAGULATION, BLOOD TRANSFUSION REQUIREMENTS, AND SURVIVAL

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Background: Traumatic Brain Injury (TBI) is the "signature injury" of our current conflicts. **Objectives:** To analyze U.S. Combat Casualty records from the DoDTR for the impact of TBI on coagulation and acid-base status, massive transfusion (MT) requirement, and survival. **Methods:** Retrospective cohort analysis. The independent variable was the Abbreviated Injury Scale (AIS) for head and facial injuries, with AIS-HEAD ≥ 3 as our TBI criteria. Other primary variables included serum pH divided by INR/MT defined as >10 units of blood products within the first 24 h, AIS regional scores exclusive of the head, and 30-day survival. We employed descriptive statistics, contingency table analysis, and multiple logistic regression.

Results: A total of 8,913 cases were available: 4,002 (45%) had data that included INR and serum pH. Of excluded cases, 98% were male, average age 26, 98.7% survived, average ISS was 7 (IQR 1.8), and less than 2% received MT. Among included cases, 98% were male, average age 26, average ISS was 10 (IQR 2–14), average INR was 1.16 (CI95 1.14–1.17), 6.2% received MT, and 98.5% survived. 425 cases had an AIS-Head ≥ 3 (10.6%). The univariate odds ratio (OR) for mortality was 8.7 (CI95 5.2–14.8; $\chi^2 = 103.7$; $df = 1$; $p = 3$ vs. others follow: INR 1.2 (1.13–1.27) vs. 1.10 (1.13–1.16); pH 7.37 (7.36–7.38) vs. 7.38 (7.38–7.39); and MT 16.9% vs. 4.9%, OR 3.9 (2.9 TO 5.4; $\chi^2 = 95.2$; $df = 1$; $p < 0.001$). After controlling for all other AIS body regions, OR for mortality was 12.6 (CI 95 7.3–21.7). After controlling for pH/INR index, the OR for mortality was 3.8 (CI95 2.1–6.8). After controlling for all other AIS body regions, the OR for MT was 3.4 (CI95 2.3–4.9). After controlling for pH / INR index, the OR for MT was 2.6 (CI95 1.9–3.6). **Conclusion:** Casualties with serious TBI were independently associated with increased mortality and MT. Earlier resuscitation focusing on optimizing tissue perfusion and oxygenation, and mitigating coagulopathy may improve survival outcome.

155. GLASS INTACT ASSURES SAFE THORACIC AND LUMBAR SPINE

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Background: Evaluation of a motor-vehicle collision victim's thoracolumbar spine is challenging due to the lack of validated clinical risk stratification rules. Despite positive steps by many EMS systems to decrease spinal immobilization and associated morbidity, there is still difficulty for treating clinicians to decide which patients to image. Prior attempts at TL-spine clearance criteria derivation have not produced robust decision instruments. **Objectives:** Assess the ability of an objective field test to exclude TL-spine injury. We hypothesized that

if the forces involved in an MVC are not sufficient enough to break any of the automobile's windows, then these forces would not cause significant TL-spine injury, defined as an Abbreviated Injury Score of 2 or greater. **Methods:** Using a nested retrospective cohort format, we studied data from the National Highway Traffic Safety Administration's National Automotive Sampling System's Crashworthiness Data System from 1998–2008. We selected only belted front seat occupants, aged 16–60 years, who did not have an airbag deploy, and who were in cars with raised windows. We then compared the incidence of TL-spine injuries in subjects with intact and non-intact greenhouses. **Results:** We examined data from 14,191 front seat occupants who were in an MVC. Of these, 72 had significant t-spine injuries and 103 had significant l-spine injuries. Intact glass decreases the odds (likelihood) of sustaining a T-spine injury (AIS 2+) by 70 (95% CI: 11,432) and an L-spine injury (AIS 2+) by 8 (95% CI: 2, 33). **Conclusion:** Negative GLASS predicts the absence of significant TL-spine injury. This GLASS rule may allow pre hospital providers and emergency physicians to clear patients for thoracolumbar spine trauma based on these objective criteria only. Prospective validation is needed before clinical application is appropriate. A primary limitation of the study that it is a retrospective cohort analysis utilizing a national database of police-reported tow-away crashes, which may not be the same patient population seen by EMS or ED providers. A prospectively conducted study is needed to further clarify the actual characteristics of the rule with regard to sensitivity and specificity, as well as ease of implementation, decrease in radiography, and potential cost savings.

156. A SOFT TISSUE CLAMP HAS LIMITED USE IN THE LARGE URBAN EMS SETTING FOR BLEEDING CONTROL

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Background: The iTClamp™ is a soft tissue clamp designed to stop hemorrhage by approximating wound edges. The creation of a pool of blood under the wound is thought to tamponade ongoing bleeding and form a stable clot until the wound can be surgically repaired. Due to the dearth of research on the iTClamp, we conducted a project to evaluate the iTClamp for feasibility of use in a large, urban, fire-based EMS system. **Objectives:** We hypothesized that there will be limited use and effectiveness in a large, urban, EMS system. **Method:** This was a prospective observational efficacy case series. Fire and EMS providers from a large, urban, fire-based EMS system received manufacturer training, and the devices were placed on all first response and transport units. The protocol indicated use in potentially life threatening hemorrhage where conventional hemorrhage control methods were not successful or contraindicated. Each use of the clamp by EMS providers underwent a chart review, and the receiving facility reported outcome data. **Results:** During the time period from 11/2014–4/2015, the clamp was applied to only 16 patients. Median age was 42 [SD \pm 18, 95% CI 33–51] years old, and 43% female. The clamp was used in the following locations: Scalp/Face–7 (44%), Torso–2 (13%), Extremity–7 (44%). Arterial hemorrhage was documented in 6 cases with hemostasis in 5 (83%). Hospital data showed that the device was used appropriately in 12 (75%) of cases. There were 2 causes of harm caused by the clamp: (1) tearing of the scalp in an elderly patient and (2) a needle stick exposure after a failed application. A total of 6 of 7 cases of scalp wounds where the clamp was correctly applied resulted in hemostasis. **Conclusion:** The iTClamp had a limited effectiveness in this large, urban, fire-based EMS system. The device was most frequently used on the scalp/face and extremities, and the clamp obtained hemostasis in most applications.