

1. **Smida T, Menegazzi JJ, Crowe RP, Bardes J, Scheidler JF, Salcido DD. Association of prehospital post-resuscitation peripheral oxygen saturation with survival following out-of-hospital cardiac arrest. Resuscitation. 2022 Dec;181:28-36. doi: 10.1016/j.resuscitation.2022.10.011. Epub 2022 Oct 19. PMID: 36272616.**

The objective of the study was to retrospectively examine the association of prehospital post-ROSC hypoxia and hyperoxia with the primary outcome of survival to discharge home. 2019-2021 ESO Data Collaborative public use research datasets were used for this study. Average prehospital SpO<sub>2</sub>, lowest recorded prehospital SpO<sub>2</sub>, and hypoxia dose were calculated for each patient. The association of these measures with survival was explored using multivariable logistic regression. Prehospital post-ROSC hypoxia and hyperoxia were associated with worse outcomes in this dataset. After application of exclusion criteria, 19,023 patients were included in this study. Of these, 52.3% experienced at least one episode of post-ROSC hypoxia (lowest SpO<sub>2</sub> < 90%) and 19.6% experienced hyperoxia (average SpO<sub>2</sub> > 98%). In comparison to normoxic patients, patients who were hypoxic on average (AHA aOR: 0.31 [0.25, 0.38]; ERC aOR: 0.34 [0.28, 0.42]) and patients who had a hypoxic lowest recorded SpO<sub>2</sub> (AHA aOR: 0.48 [0.39, 0.59]; ERC aOR: 0.52 [0.42, 0.64]) had lower adjusted odds of survival. Patients who had a hyperoxic average SpO<sub>2</sub> (AHA aOR: 0.75 [0.59, 0.96]; ERC aOR: 0.68 [0.53, 0.88]) and patients who had a hyperoxic lowest recorded SpO<sub>2</sub> (AHA aOR: 0.66 [0.48, 0.92]; ERC aOR: 0.65 [0.46, 0.92]) also had lower adjusted odds of survival.

2. **Joiner A, Fernandez AR, Van Vleet L, Cabañas JG, Grover J, Godfrey A, Crowe R, Staton C, Pavon J. Predictors of Non-Transport for Older Adult EMS Patients Encountered for Falls. Prehosp Emerg Care. 2022 Oct 28:1-7. doi: 10.1080/10903127.2022.2137744. Epub ahead of print. PMID: 36251394.**

The objective of this study was to describe characteristics associated with non-transport among older adult EMS patients encountered for falls. A national retrospective cross-sectional study of 9-1-1 patient contacts was conducted using data from the 2019 ESO Data Collaborative. Potential predictors of non-transport included patient demographics, initial vital signs, who requested 9-1-1 service, incident location, alcohol/substance use, and urbanicity. Multivariable logistic regression was used to determine associations between non-transport and potential predictors. Males, older age groups, and Hispanic/Latino patients had higher odds of non-transport among this population of community-dwelling adults aged 60 or greater. 195,204 EMS encounters for older adults who fell in 2019 were identified, including 27,563 (14.1%) non-transports. Most patients were female (62.4%), non-Hispanic White (85.4%), and fell at a home or residence (80.4%). Greater odds of non-transport were identified among males (OR 1.37, 95% CI 1.32-1.42) and Hispanic/Latino patients (OR 1.24, 95% CI 1.14-1.35). Older age was associated with greater odds of non-transport compared to patients aged 60-69 years (70-79 [OR 1.42, 95% CI 1.35-1.49], 80-89 [OR 1.51, 95% CI 1.42-1.59], ≥90 [OR 1.45, 95% CI 1.35-1.55]). Patients residing in Census tracts with larger percentages of the population living in poverty had lower odds of non-transport compared to those in areas with ≤5% in poverty (6-15% poverty [OR 0.82, 95% CI 0.78-0.84], 15-25% poverty [OR 0.78, 95% CI 0.73-0.82], and >25% poverty [OR 0.78, 95% CI 0.72-0.84]).

- 3. Smida T, Menegazzi JJ, Crowe RP, Weiss LS, Salcido DD. Association of prehospital hypotension depth and dose with survival following out-of-hospital cardiac arrest. Resuscitation. 2022 Sep 30;180:99-107. doi: 10.1016/j.resuscitation.2022.09.018. Epub ahead of print. PMID: 36191809.**

The study objective was to examine the association between duration and depth of prehospital post return of spontaneous circulation (ROSC) hypotension and survival. Data from the 2019 and 2020 ESO Data Collaborative research data set were analyzed. Hypotension dose (mmHg\*min.), average prehospital systolic blood pressure (SBP), and lowest recorded prehospital SBP were calculated. The association of these measures with survival to home (STH) and rearrest were explored using multivariable logistic regression. Time to hypotension resolution analyses by hypotension management strategy (push dose vasopressors, vasopressor infusion, or fluid only) were conducted using adjusted Cox proportional hazards models. Severity and duration of hypotension were significantly associated with worse outcomes in this dataset. 17,280 OHCA patients met inclusion criteria, of which 3,345 had associated hospital outcome data. Over one-third (37.8%; 6,526/17,280) of all patients had at least one recorded SBP below 90 mmHg. When modeled continuously, average prehospital SBP (1.19 [1.15, 1.23] per 10 mmHg), lowest prehospital SBP (1.20 [1.17, 1.24] per 10 mmHg), and hypotension dose (0.995 [0.993, 0.996] per mmHg\*min.) were independently associated with STH. Differences in hypotension management were not associated with differences in survival or time to hypotension resolution.

- 4. Guterman EL, Sporer KA, Newman TB, Crowe RP, Lowenstein DH, Josephson SA, Betjemann JP, Burke JF. Real-World Midazolam Use and Outcomes With Out-of-Hospital Treatment of Status Epilepticus in the United States. Ann Emerg Med. 2022 Oct;80(4):319-328. doi: 10.1016/j.annemergmed.2022.05.024. Epub 2022 Aug 2. PMID: 35931608.**

The aim of this study was to examine the effectiveness of midazolam in a national out-of-hospital cohort. 2019 data from the ESO Data Collaborative research dataset was used to conduct a retrospective cohort study of adults with status epilepticus. There were 7,634 out-of-hospital encounters from 657 EMS agencies. Midazolam was administered intranasally in 20%, intravenously in 46%, and intramuscularly in 35% of the encounters. Compared with intramuscular administration, intranasal midazolam increased (risk difference [RD], 6.5%; 95% confidence interval [CI], 2.4% to 10.5%) and intravenous midazolam decreased (RD, -11.1%; 95% CI, -14.7% to -7.5%) the risk of rescue therapy. The differences in ventilatory support were not statistically significant (intranasal RD, -1.5%; 95% CI, -3.2% to 0.3%; intravenous RD, -0.3%; 95% CI, -1.9% to 1.2%). Higher doses were associated with a lower risk of rescue therapy (RD, -2.6%; 95% CI, -3.3% to -1.9%) and increased ventilatory support (RD, 0.4%; 95% CI, 0.1% to 0.7%). The instrumental variable analysis yielded similar results, except that dose was not associated with ventilatory support. Compared with intramuscular administration, intranasal administration may be less effective and intravenous administration more effective in terminating status epilepticus, although the differences between these and previous results may reflect the nature of real-world data as opposed to randomized data.

- 5. Aceves A, Crowe RP, Zaidi HQ, Gill J, Johnson R, Vithalani V, Fairbrother H, Huebinger R. Disparities in Prehospital Non-Traumatic Pain Management. Prehosp Emerg Care. 2022 Sep 6:1-6. doi: 10.1080/10903127.2022.2107122. Epub ahead of print. PMID: 35939557.**

The study objective was to evaluate EMS encounters for racial and ethnic disparities in analgesia given for non-traumatic pain. 2018 and 2019 data from the ESO Data Collaborative was used in this analysis. All transported, adult, non-traumatic encounters with a primary or secondary

impression of a pain complaint were included and stratified based on race and ethnicity as recorded by the EMS clinicians. A mixed model analysis was performed, modeling EMS agency as a random intercept and adjusting for age, sex, pain location, level of service, location of incident, and highest pain score. The association between race/ethnicity and receiving any pain medication (acetaminophen, non-steroidal anti-inflammatories, or opioids), receiving opioid pain medication, and receiving pain medication within 20 minutes of EMS arrival was evaluated using non-Hispanic White patients as the reference group. 1,035,486 patients were included in this analysis; 67.5% non-Hispanic White, 26.8% Black, 4.9% Hispanic, 0.5% Asian, 0.1% Native Hawaiian or Other Pacific Islander, and 0.2% American Indian or Alaska Native patients. 4.7% of patients received pain medications. Compared to White patients (5.1%), Black patients were less likely to receive pain medication (3.3%, aOR 0.7; 95% CI 0.7-0.7) and Hispanics were more likely to receive pain medication (7.6%, aOR 1.5; 95% CI 1.4-1.6). Black patients were also less likely to receive opioids (1.8% for Black v 3.0% for White, aOR 0.7; 95% CI 0.6-0.7), while Hispanic patients were more likely to receive opioids (4.9%, aOR 1.4; 95% CI 1.3-1.5). The odds of receiving pain medication within 20 minutes was lower for Black patients (aOR 0.9; 95% CI 0.8-0.95) but no different for Hispanic patients (aOR 1.0; 95% CI 0.9-1.1), when compared to White patients.

**6. Guterma EL, Sporer KA, Newman TB, Crowe RP, Lowenstein DH, Josephson SA, Betjemann JP, Burke JF. Real-World Midazolam Use and Outcomes With Out-of-Hospital Treatment of Status Epilepticus in the United States. *Ann Emerg Med.* 2022 Aug 2:S0196-0644(22)00363-8. doi: 10.1016/j.annemergmed.2022.05.024. Epub ahead of print. PMID: 35931608.**

The study objective was to examine the effectiveness of midazolam in a national out-of-hospital cohort. A retrospective cohort study of adults with status epilepticus using the ESO Data Collaborative 2019 research dataset was conducted. The exposures were the route and dose of midazolam. A hierarchical logistic regression and 2-stage least squares regression were performed using agency treatment patterns as an instrument to examine our outcomes, rescue therapy, and ventilatory support. The route and dose of midazolam affect clinical outcomes. Compared with intramuscular administration, intranasal administration may be less effective and intravenous administration more effective in terminating status epilepticus, although the differences between these and previous results may reflect the nature of real-world data as opposed to randomized data. There were 7,634 out-of-hospital encounters from 657 EMS agencies in this analysis. Midazolam was administered intranasally in 20%, intravenously in 46%, and intramuscularly in 35% of the encounters. Compared with intramuscular administration, intranasal midazolam increased (risk difference [RD], 6.5%; 95% confidence interval [CI], 2.4% to 10.5%) and intravenous midazolam decreased (RD, -11.1%; 95% CI, -14.7% to -7.5%) the risk of rescue therapy. The differences in ventilatory support were not statistically significant (intranasal RD, -1.5%; 95% CI, -3.2% to 0.3%; intravenous RD, -0.3%; 95% CI, -1.9% to 1.2%). Higher doses were associated with a lower risk of rescue therapy (RD, -2.6%; 95% CI, -3.3% to -1.9%) and increased ventilatory support (RD, 0.4%; 95% CI, 0.1% to 0.7%). The instrumental variable analysis yielded similar results, except that dose was not associated with ventilatory support.

**7. Goyal A, Frawley J, Gappy R, Sandoval S, Chen NW, Crowe RP, Swor R. Prehospital Ketamine Use in Pediatrics. *Prehosp Emerg Care.* 2022 Jul 19:1-6. doi: 10.1080/10903127.2022.2096161. Epub ahead of print. PMID: 35771721.**

The study objective was to describe patient characteristics among pediatric EMS patients who received ketamine. Records from the 2019 and 2020 ESO Data Collaborative for all 911 transports of pediatric patients ( $\leq 18$  years of age) who received ketamine were used for this

analysis. EMS primary impressions were used as a proxy for medication indication. Most patients were observed to improve after ketamine use and most injured patients reported decreases in pain scores. Few significant adverse events related to ketamine use in this population were observed. Out of 422,968 ground-ambulance pediatric patients, 1,291 received ketamine. They were predominately male (842, 65.2%), teenagers (median age 16, IQR: 13-17), Caucasian (810, 62.7%), and from urban areas (1,041, 80.6%). The most common EMS impressions were related to injuries (810, 62.7%) and behavior disorders (281, 21.8%). Only 980/1,291 (75.9%) had weights and identifiable routes recorded. Most patients (960, 74.4%) received single doses of ketamine, with EMS clinicians reporting improvement in 855 (89.1%) of 960 patients. Among non-behavioral emergency patients, 727/1,010 (72.0%) had pain scores recorded. Pain scores decreased significantly from a median of 8 (IQR: 4-10) to 2 (IQR: 0-6) ( $p < 0.001$ ) with 59% (429) of 727 patients reporting pain score reductions of 2 or more points. Desaturation (<90% SpO<sub>2</sub>) events were noted to be minimal (1.8%). A small number (28, 2.2%) received positive pressure ventilation without advanced airway placement. No prehospital deaths were documented.

**8. Harris M, Crowe RP, Anders J, D'Acunto S, Adelgais KM, Fishe JN. Identification of Factors Associated with Return of Spontaneous Circulation after Pediatric Out-of-Hospital Cardiac Arrest Using Natural Language Processing. Prehosp Emerg Care. 2022 May 23:1-8. doi: 10.1080/10903127.2022.2074180. Epub ahead of print. PMID: 35510881.**

The study objective was to use Natural Language Processing (NLP) to examine EMS clinician free-text narratives for characteristics associated with prehospital return of spontaneous circulation (ROSC) in pediatric out-of-hospital cardiac arrest (OHCA). Records from the 2019 ESO Data Collaborative of patients ages 0-17 with OHCA were used in this analysis. An exploratory analysis of EMS narratives was performed using NLP with an a priori token library; biostatistical and machine learning models compared performance in predicting ROSC. Free-text narratives revealed additional characteristics associated with prehospital ROSC in pediatric OHCA and incorporation of those terms into machine learning models of prehospital ROSC improved predictive ability. There were 1,726 EMS encounters for pediatric OHCA included for analysis; 60% were male patients, and the median age was 1 year (IQR 0-9). Most cardiac arrest events (61.3%) were unwitnessed, 87.3% were identified as having medical causes, and 5.9% had initial shockable rhythms. Prehospital ROSC was achieved in 23.1%. Words most positively correlated with ROSC were "ROSC" ( $r = 0.42$ ), "pulse" ( $r = 0.29$ ), "drowning" ( $r = 0.13$ ), and "PEA" ( $r = 0.12$ ). Words negatively correlated with ROSC included "asystole" ( $r = -0.25$ ), "lividity" ( $r = 0.14$ ), and "cold" ( $r = -0.14$ ). The terms "asystole," "pulse," "no breathing," "PEA," and "dry" had the greatest difference in frequency of appearance between encounters with and without ROSC ( $p < 0.05$ ). The best-performing model for predicting prehospital ROSC was logistic regression with random oversampling using free-text data only (area under the receiver operating characteristic curve 0.92).

**9. Lowery B, D'Acunto S, Crowe RP, Fishe JN. Using Natural Language Processing to Examine Social Determinants of Health in Prehospital Pediatric Encounters and Associations with EMS Transport Decisions. Prehosp Emerg Care. 2022 May 23:1-6. doi: 10.1080/10903127.2022.2072984. Epub ahead of print. PMID: 35500212.**

The study objective was to examine the presence of social determinants of health (SDOH) in EMS clinician free text notes and quantify the association of SDOH with EMS pediatric transport decisions. The 2019 ESO Data Collaborative research dataset was used in this analysis using records from patients ages 0-17; cases of cardiac arrests and patients in law enforcement custody were excluded from the analysis. Natural language processing (NLP) was used to extract the

following SDOH categories: income insecurity, food insecurity, housing insecurity, insurance insecurity, poor social support, and child protective services. SDOH documentation in the EMS narrative was rare among pediatric encounters; however, children with documented SDOH were more likely to be transported. 325,847 pediatric EMS encounters were analyzed, of which 35% resulted in non-transport. The median age was 10 years and 52% were male. Slightly over half (53%) were White, 31% were Black, and 11% were Hispanic. Child protective services (n = 2,620) and housing insecurity (n = 1,136) were the most common SDOH categories found in the EMS free text narratives. In the multivariable model, child protective services involvement (odds ratio (OR)=2.04 [95% confidence interval (CI) 1.84-2.05]), housing insecurity (OR= 1.46 [95% CI 1.26-1.70]), insurance security (OR= 2.44 [95% CI 1.93-3.09]), and poor social support (OR= 10.48 [95% CI 1.42-77.29]) were associated with greater odds of EMS transport.

- 10. Brown, LH., Crowe, RP., Pepe, PE., Miller, ML., Watanabe, BL., Kordik, SS., Wampler, DA., Page, DI., Fernandez, AR., Bourn, SS., & Myers, JB. (2022, May). Adverse events following emergent prehospital sedation of patients with behavioral emergencies: A retrospective cohort study. The Lancet Regional Health - Americas, 9, 100183. <https://doi.org/10.1016/j.lana.2021.100183>. Epub 2022 Jan 15.**

The study objective was to describe the frequency of adverse events (AEs) following emergent prehospital sedation with three types of sedative agents: ketamine, benzodiazepines, and antipsychotics. 2019 data from the ESO Data Collaborative was used in this analysis. The study looked at patients  $\geq 15$  years who presented with behavioral emergencies necessitating emergent prehospital sedation. Serious AEs (SAE) included cardiac arrest, invasive airway placement, and severe oxygen desaturation ( $<75\%$ ). Less-serious AEs included positive pressure ventilation, any oxygen desaturation ( $<90\%$ ), oropharyngeal or nasopharyngeal airway placement, and suctioning. The need for additional sedation was also assessed. Although SAEs were rare among patients receiving emergent prehospital sedation, prehospital clinicians should remain mindful of the potential risks and monitor patients closely. Of 7973 patients, 1996 received ketamine; 4137 received benzodiazepines; 1532 received an antipsychotic agent; and 308 received an indeterminate agent. Cardiac arrest occurred in 11 patients (0.1%) and any SAE occurred in 165 patients (2.1%). Invasive airway placement was more frequent with ketamine (40, 2.0%) compared with benzodiazepines (17, 0.4%) or antipsychotics (3, 0.2%). Oxygen desaturation below 75% also occurred more frequently with ketamine (51, 2.6%) than with benzodiazepines (52, 1.3%) or antipsychotics (14, 0.9%). Patients sedated with ketamine were less likely to require additional sedation.

- 11. Ashburn, NP., Snavely, AC., Angi, RM., Scheidler, JF., Crowe, RP., McGinnis, HD., Hiestand, BC., Miller, CD., Mahler, SA., Stopyra, JP. Prehospital time for patients with acute cardiac complaints: A rural health disparity. Am J Emerg Med. 2022 Feb;52:64-68. doi: 10.1016/j.ajem.2021.11.038. Epub 2021 Nov 30. PMID: 34871845.**

The study objective was to quantify rural and urban differences in prehospital time intervals for patients with cardiac complaints. The ESO Data Collaborative dataset consisting of records from 1332 EMS agencies was queried for 9-1-1 encounters with acute cardiac problems among adults (age  $\geq 18$ ) from 1/1/2013-6/1/2018. Location was classified as rural or urban using the 2010 United States Census. The primary outcome was total prehospital time. Generalized estimating equations evaluated differences in the average times between rural and urban encounters while controlling for age, sex, race, transport mode, loaded mileage, and patient stability. Rural patients with acute cardiac complaints experienced longer prehospital time than urban patients, even after accounting for other key variables, such as loaded mileage. Among 428,054 encounters,

the median age was 62 (IQR 50-75) years with 50.7% female, 75.3% white, and 10.3% rural. The median total prehospital, response, scene, and transport times were 37.0 (IQR 29.0-48.0), 6.0 (IQR 4.0-9.0), 16.0 (IQR 12.0-21.0), and 13.0 (IQR 8.0-21.0) minutes. Rural patients had an average total prehospital time that was 16.76 min (95%CI 15.15-18.38) longer than urban patients. After adjusting for covariates, average total time was 5.08 (95%CI 4.37-5.78) minutes longer for rural patients. Average response and transport time were 4.36 (95%CI 3.83-4.89) and 0.62 (95%CI 0.33-0.90) minutes longer for rural patients. Scene time was similar in rural and urban patients (0.09 min, 95%CI -0.15-0.33).

**12. Hanna, A., Crowe, RP., Fische, JN. Pediatric Bradycardia Is Undertreated in the Prehospital Setting: A Retrospective Multi-Agency Analysis. Prehosp Emerg Care. 2022 Jan 25:1-6. doi: 10.1080/10903127.2021.2018075. Epub ahead of print. PMID: 34913820.**

The study objective was to investigate the incidence and management of pediatric bradycardia in the prehospital setting by emergency medical services. The 2019 ESO Data Collaborative research dataset was used for this analysis. All 911 scene response prehospital encounters for patients ages 0-18 were included. Age-based bradycardia was identified per the 2015 AHA PALS guidelines. The analysis included general descriptive statistics and a univariate analysis examining any PALS-recommended interventions in the presence of altered mental status, hypotension for age, and a first heart rate less than 60. Incidence of prehospital pediatric bradycardia was rare, but adherence to PALS guidelines was variable. Of the 7,422,710 encounters in the 2019 ESO Data Collaborative, 1,209 patients met inclusion criteria. Most (58.5%) were male, and the median age was 2 years (interquartile range 0-13 years). One-quarter (24.7%) of patients received fluids, and bag-valve mask ventilation was the most common airway intervention (12.1% of patients). Receipt of any PALS-recommended interventions was associated with age-adjusted hypotension (odds ratio (OR) 4.0, 95% confidence interval (CI) 3.9-5.4) and altered mental status (OR 15.5, 95% CI 10.7-22.3), but not a first heart rate less than 60 bpm (OR 0.9, 95% CI 0.6-1.1).

**13. Harris, MI., Crowe, RP., Anders, J., D'Acunto, S., Adelgais, KM., Fische, J. Applying a set of termination of resuscitation criteria to paediatric out-of-hospital cardiac arrest. Resuscitation. (2021) Dec;169:175-181. doi: 10.1016/j.resuscitation. 2021.09.015. Epub 2021 Sep 20. PMID: 34555488.**

The study objective was to apply a set of criteria for pediatric prehospital termination of resuscitation (pTOR) from the Maryland Institute for Emergency Medical Services Systems (MIEMSS) to a large national cohort and determine its association with return of spontaneous circulation (ROSC) after POHCA. The 2019 ESO Data Collaborative research dataset was used for this analysis. Patients ages 0-17 treated by EMS with cardiac arrest were included and the applicable pTOR criteria for medical or traumatic arrests was applied. There were 1595 POHCA patients. Eighty-eight percent (n = 1395) were classified as medical. ROSC rates were 23% among medical POHCA and 27% among traumatic POHCA. The medical criteria correctly classified >99% (322/323) of patients who achieved ROSC as ineligible for TOR. The trauma criteria correctly classified 93% (50/54) of patients with ROSC as ineligible for TOR. Of the five misclassified patients, three were involved in drowning incidents. The Maryland pTOR criteria identified eligible patients who did not achieve prehospital ROSC, while reliably excluding those who did achieve prehospital ROSC. As most misclassified patients were victims of drowning, we recommend considering the exclusion of drowning patients from future pTOR guidelines. Further studies are needed to evaluate the long-term survival and neurologic outcome of patients misclassified by pTOR criteria.

**14. Popp, LM., Lowell, LM., Ashburn, NP., Stopyra, JP. Adverse events after prehospital nitroglycerin administration in a nationwide registry analysis. Am J Emerg Med. (2021) Dec;50:196-201. doi: 10.1016/j.ajem.2021.08.006. Epub 2021 Aug 8. PMID: 34390902.**

The study objective was to determine demographic and clinical factors associated with adverse events after prehospital NTG administration. The 2019 ESO Data Collaborative research dataset was used for this analysis. All 911 encounters where NTG was administered to patients  $\geq 18$  years old by EMS were included. Adverse event outcomes were defined as a new systolic blood pressure (SBP)  $< 90$ , heart rate (HR)  $< 50$  or  $> 120$ , mean arterial pressure (MAP)  $< 65$ , or change in mental status following NTG administration. Descriptive statistics and logistic regression models adjusting for age, sex, race, ethnicity, intravenous (IV) access, and initial vital signs were used to assess for adverse event-related factors. Among 80,760 encounters, the mean age was 61 (IQR 50-72), with 52% males, 71% white race, and 7% Hispanic ethnicity. Adverse events occurred in 7% of encounters. Adverse events were found to be less common among Black patients (OR = 0.74, 95%CI:0.69-0.80). IV access obtained prior to NTG administration was associated with fewer adverse events (OR = 0.92, 95%CI:0.85-0.99). Increasing age (OR = 1.02, 95%CI:1.01-1.02) and HR (OR = 1.03, 95%CI:1.02-1.03) were associated with increased odds of adverse events while SBP (OR = 0.99, 95%CI:0.98-0.99) was inversely associated. Adverse events following prehospital NTG administration were rare, especially in patients with an SBP  $> 110$  and a HR  $< 100$ , and less frequent in those with existing IV access. Demographics were not found to be clinically significant.

**15. Walter, DC., Chan, KC., Crowe, RP., Osborn, L., Jarvis, J., Wang, HE. Out-of-hospital, non-invasive, positive-pressure ventilation for acute dyspnea. J Am Coll Emerg Physicians Open. (2021) Nov 4;2(6):e12542. doi: 10.1002/emp2.12542. PMID: 34761248; PMCID: PMC8567746.**

The study objective was to determine the course and outcomes of out-of-hospital acute dyspnea patients treated with non-invasive, positive-pressure ventilation (NIPPV), including continuous positive airway pressure (CPAP) or bi-level positive air pressure (BPAP). This retrospect analysis utilized the 2018 ESO Data Collaborative research database. Acute dyspnea was defined as adults with an initial respiratory rate  $\geq 30$  breaths/min (bpm), with a primary or secondary EMS subjective impression of a respiratory condition, who received oxygen and/or a respiratory medication and had 2 or more recordings of respiratory rate (RR). Patients with trauma and those with altered mental status were excluded. The primary outcome was change in respiratory rate (RR), censored at 90 minutes of treatment. There were 33,585 EMS encounters for patients with acute dyspnea, including 8,750 (26.1%) NIPPV and 24,835 (73.9%) non-NIPPV encounters. Median treatment duration was similar between NIPPV and non-NIPPV (23.3 minutes vs 23.6 minutes, rank-sum P = 0.266). Common concurrent treatments included albuterol (NIPPV, 48.8%; non-NIPPV, 46.2%), ipratropium bromide (27.9%, 24.8%), and methylprednisolone (24.9%, 18.5%). At 20 minutes, mean RR change was slightly lower for the NIPPV group than non-NIPPV; -6.0 versus -6.8 breaths/min. At 40 minutes, mean RR change was similar between NIPPV and non-NIPPV groups; -7.7 versus -7.9 breaths/min. On linear mixed modeling adjusted for age, sex, incident location, race, ethnicity, agency type, initial RR, and medication use, NIPPV was associated with a smaller RR decrease across time than NIPPV; [NIPPV  $\times$  time] interaction P  $< 0.001$ . Out-of-hospital advanced airway placement (endotracheal intubation or supraglottic airway insertion) was higher for NIPPV than non-NIPPV group (2.3% vs 1.3%, odds ratio = 2.23, 95% confidence interval = 2.01-2.47).

- 16. Clemency, BM., Murk, W., Moore, A., Brown, LH. The EMS Modified Early Warning Score (EMEWS): A Simple Count of Vital Signs as a Predictor of Out-of-Hospital Cardiac Arrests. Prehosp Emerg Care. (2021) Apr 13:1-22. doi: 10.1080/10903127.2021.1908464. Epub ahead of print. PMID: 33794729.**

The study objective was to compare to the ability of Modified Early Warning Score (MEWS) and “EMS Modified Early Warning Score” (EMEWS) to identify patients at risk for EMS-witnessed out-of-hospital cardiac arrest (OHCA). This retrospect analysis utilized the 2018 ESO Data Collaborative research database. Patients without cardiac arrest before EMS arrival were categorized into those who did or did not have an EMS-witnessed arrest. MEWS was evaluated without its temperature component (MEWS-T). The performance of MEWS-T and EMEWS in predicting EMS witnessed arrest was evaluated by comparing receiver-operating characteristic curves. Of 369,064 included encounters, 4,651 were EMS witnessed arrests. MEWS-T demonstrated an area under the curve (AUC) of 0.79 (95% CI: 0.79 - 0.80), with 86.8% sensitivity and 51.0% specificity for MEWS-T  $\geq$  3. EMEWS demonstrated an AUC of 0.74 (95% CI: 0.73 - 0.75), with 81.3% sensitivity and 53.9% specificity for EMEWS  $\geq$  2. EMEWS showed a similar ability to predict EMS-witnessed cardiac arrest compared to MEWS-T, despite being significantly simpler to compute. Further study is needed to evaluate whether the implementation of EMEWS can aid EMS clinicians in anticipating and preventing OHCA.

- 17. Bourn, S.S., Crowe, R.P., Fernandez, A.R., Matt, S.E., Brown, A.L., Hawthorn, A.B., Myers, J.B. (2021): Initial prehospital Rapid Emergency Medicine Score (REMS) to predict outcomes for COVID-19 patients. JACEP Open. <https://doi.org/10.1002/emp2.12483>**

The study objective was to determine whether the first prehospital REMS could predict emergency department and hospital dispositions for COVID-19 patients transported by emergency medical services. This study used linked prehospital and hospital records from the ESO Data Collaborative for all 911-initiated transports of patients with hospital COVID-19 diagnoses from July 1 to December 31, 2020. REMS was calculated with the first recorded prehospital values for each component. Area under the receiver operating curve (AUROC) was calculated for emergency department (ED) mortality, ED discharge, hospital mortality, and hospital length of stay (LOS). Optimal REMS cut-points were determined using test characteristic curves. Among 13,830 included COVID-19 patients, median REMS was 6 (interquartile range [IQR]: 5-9). ED mortality was <1% (n = 80). REMS  $\geq$ 9 predicted ED death (AUROC 0.79). One-quarter of patients (n = 3,419) were discharged from the ED with an optimal REMS cut-point of  $\leq$ 5 (AUROC 0.72). Eighteen percent (n = 1,742) of admitted patients died. REMS  $\geq$ 8 optimally predicted hospital mortality (AUROC 0.72). Median hospital LOS was 8.3 days (IQR: 4.1-14.8 days). REMS  $\geq$ 7 predicted hospitalizations  $\geq$ 3 days (AUROC 0.62). Initial prehospital REMS was modestly predictive of ED and hospital dispositions for patients with COVID-19. Prediction was stronger for outcomes more proximate to the first set of emergency medical services (EMS) vital signs.

- 18. Fernandez, AR., Bourn, SS., Crowe, RP., Bronsky, ES., Schepke, KA., Antevy, P., Myers, JB. Out-of-Hospital Ketamine: Indications for Use, Patient Outcomes, and Associated Mortality. Ann Emerg Med. (2021) Jul;78(1):123-131. doi: 10.1016/j.annemergmed.2021.02.020. Epub 2021 Jun 7. PMID: 34112540.**

The study objective was to describe prehospital ketamine use, patient outcomes, and the potential contribution of ketamine to patient death. Using the ESO Data Collaborative, all 911 responses with prehospital ketamine administration from 1/1/2019 to 12/31/2019, excluding cardiac arrest prior to EMS arrival were queried. Measures included indications for ketamine administration, dosing, route, transport disposition, hypoxia, hypercapnia, and mortality. In cases

involving patient death, physician review and consensus was used to determine whether ketamine could be excluded as a potential contributing factor. Descriptive statistics were calculated. There were 15,204 prehospital ketamine administrations among 11,291 patients. Indications included trauma/pain (49%, 5,575), altered mental status/behavioral (34%, 3,795), cardiovascular/pulmonary (13%, 1,454), seizure (2%, 248), and other (2%, 219). Median dose was highest for altered mental status/behavioral indications at 3.7 mg/kg (interquartile range: 2.2-4.4 mg/kg). Over 99% (11,274) were transported to a hospital. Following ketamine administration, hypoxia and hypercapnia were documented in 8.4% (897) and 17.2% (1,311) of patients, respectively. Eight on-scene and 120 in-hospital deaths were reviewed. Ketamine could not be excluded as a contributing factor in 2 on-scene deaths representing 0.02% (95% CI: 0.00-0.07%) of all exposures. Among in-hospital deaths, ketamine could not be excluded as a contributing factor in 6 cases (0.3%, 95% CI: 0.1-0.7%).

**19. Huebinger RM, Stilgenbauer H, Jarvis JL, Ostermayer DG, Schulz K, Wang HE. Video laryngoscopy for out of hospital cardiac arrest. Resuscitation. 2021 May;162:143-148. doi: 10.1016/j.resuscitation.2021.02.031. Epub 2021 Feb 25. PMID: 33640431.**

The study objective was to evaluate the association of video laryngoscopy (VL) with first pass success and return of spontaneous circulation (ROSC) using a national out-of-hospital cardiac arrest (OHCA) cohort. This study used the 2018 ESO Data Collaborative to evaluate all adult, non-traumatic cardiac arrests undergoing endotracheal intubation. VL and direct laryngoscopy (DL) were defined based on paramedic recorded intubation device. The primary outcomes were first pass success, return of spontaneous circulation (ROSC), and sustained ROSC. Multivariable, mixed models, were used to determine the association between VL and first pass success rate, ROSC, and sustained ROSC (survival to ED or ROSC in the field for greater than 20 min), fitting agency as a random intercept and adjusting for confounders. There were 22,132 patients cared for by 914 EMS agencies, including 5702 (25.7%) VL and 16,430 (74.2%) DL. Compared to DL, VL had a lower rate of bystander CPR, but other characteristics were similar between the groups. VL exhibited higher first pass success than DL (75.1% v 69.5%,  $p < .001$ ). On mixed model analysis, VL was associated with a higher first pass success (OR 1.5, CI 1.3-1.6) but not ROSC (OR 1.1, CI 0.97-1.2) or sustained ROSC (OR 1.1, CI 0.9-1.2). While associated with higher FPS, VL was not associated with increased rate of ROSC.

**20. Clemency B.M., Murk W., Moore A., Brown L.H., (2021): The EMS Modified Early Warning Score (EMEWS): A Simple Count of Vital Signs as a Predictor of Out-of-Hospital Cardiac Arrests. Prehosp Emerg Care. 2021 Apr 13:1-22. doi: 10.1080/10903127.2021.1908464. Epub ahead of print. PMID: 33794729.**

The study objective was to compare to the ability of the Modified Early Warning Score (MEWS) and the "EMS Modified Early Warning Score" (EMEWS) to identify patients at risk for EMS-witnessed out-of-hospital cardiac arrest. This study used the 2018 ESO Data Collaborative. Patients without cardiac arrest before EMS arrival were categorized into those who did or did not have an EMS-witnessed arrest. MEWS was evaluated without its temperature component (MEWS-T). The performance of MEWS-T and EMEWS in predicting EMS witnessed arrest was evaluated by comparing receiver-operating characteristic curves. Of 369,064 included encounters, 4,651 were EMS witnessed arrests. MEWS-T demonstrated an area under the curve (AUC) of 0.79 (95% CI: 0.79 - 0.80), with 86.8% sensitivity and 51.0% specificity for MEWS-T  $\geq$  3. EMEWS demonstrated an AUC of 0.74 (95% CI: 0.73 - 0.75), with 81.3% sensitivity and 53.9% specificity for EMEWS  $\geq$  2. EMEWS showed a similar ability to predict EMS-witnessed cardiac arrest compared to MEWS-T, despite being significantly simpler to compute.

**21. Crowe, R.P., Bourn, S.S., Fernandez, A.R., Myers, J.B. (2021): Initial Prehospital Rapid Emergency Medicine Score (REMS) as a Predictor of Patient Outcomes, Prehospital Emergency Care, DOI: 10.1080/10903127.2020.1862944**

The study objective was to assess predictive characteristics of initial prehospital Rapid Emergency Medicine Score (REMS) for ED disposition and overall patient mortality. This study used linked prehospital and Health Data Exchange records from the national ESO Data Collaborative. All 911 responses from January 1, 2019 to December 31, 2019 were included. REMS (0–26) was calculated using age and first prehospital values for: pulse rate, mean arterial pressure, respiratory rate, oxygen saturation, and Glasgow Coma Scale. Non-transport, patients <18 and cardiac arrests prior to EMS arrival were excluded. The primary outcome was ED disposition, dichotomized to discharge versus admission, transfer, or death. The secondary outcome was overall survival to discharge (ED or inpatient). Predictive ability was assessed using area under the receiver operating curve (AUROC). Optimal REMS cut points were determined using test characteristic curves. Univariable logistic regression modeling was used to quantify the association between initial prehospital REMS and each outcome. A REMS of 5 or lower demonstrated optimal statistical prediction for ED discharge versus not discharged (admission/transfer/death) (AUROC: 0.68). Patients with initial prehospital REMS of 5 or lower showed a three-fold increase in odds of ED discharge (OR: 3.28, 95%CI: 3.24–3.32). A score 7 or lower was statistically optimal for predicting survival. Initial prehospital REMS of 7 or lower was associated with a five-fold increase in odds of overall survival (OR:5.41, 95%CI:5.15–5.69).

**22. Fernandez, A.R., Crowe, R.P., Bourn, S., Matt, S.E. Brown, A.L., Hawthorn, A.B., Myers, B. COVID-19 Preliminary Case Series: Characteristics of EMS Encounters with Linked Hospital Diagnoses. Prehosp Emerg Care. 2020 Jul 31;1-12.doi: 10.1080/10903127.2020.1792016.**

The study objective was to describe prehospital encounters for patients with a COVID-19 hospital diagnosis and/or COVID-19 EMS suspicion versus those with neither a hospital diagnosis nor EMS suspicion of the disease. All ESO records for 9-1-1 responses between March 1 and April 19, 2020, resulting in transport to a hospital, with at least one ICD-10 outcome returned via the Health Data Exchange were included. COVID-19 EMS suspicion was defined as a documented EMS primary or secondary impression of COVID-19, or indication of COVID-19 suspicion in the prehospital free-text narrative. There were 84,540 EMS patient records with linked hospital ICD-10 codes included, 814 (1%) patients had a COVID-19 hospital diagnosis. Overall, COVID-19 EMS suspicion was documented for 3,204 (4%) patients. COVID-19 EMS suspicion demonstrated a sensitivity of 78% for those with a hospital diagnosis of COVID-19. Among EMS suspected COVID-19 patients, the probability of a COVID-19 hospital diagnosis was 20%. Among those patients for whom EMS did not document suspicion of COVID-19, the probability of not having a hospital diagnosis of COVID-19 was 99.8%. Those with COVID-19 hospital diagnoses were more likely to present with tachycardia, tachypnea, hypoxia, and fever during the EMS encounter. EMS responses for patients diagnosed with COVID-19 were also more likely to originate from a skilled nursing/assisted living facility. EMS PPE (eye protection, mask, or gown) use was more frequently documented on records of patients who had hospital diagnosed COVID-19.

**23. George TP, Chan HK, Crowe RP, Jarvis JL, Jansen JO, Huebinger RM, Wang HE. Clinical characteristics and course of out-of-hospital shock in a national emergency medical services cohort. J Am Coll Emerg Physicians Open. 2020 May 23;1(4):432-439. doi: 10.1002/emp2.12090. PMID: 33000067; PMCID: PMC7493535.**

The study objective was to characterize adult out-of-hospital shock care in a national EMS cohort. The 2018 ESO research dataset was used for this analysis. The study evaluated adult (age ≥18 years) non-cardiac arrest patients with shock, defined as initial systolic blood pressure ≤80 mm

Hg. Among 6,156,895 adult 911 responses, shock was present in 62,867 (1.02%; 95% confidence interval = 1.01%-1.03%); 54,239 (86.3%) medical and 5978 (9.5%) traumatic, and 2650 unknown. Medical was more common than traumatic shock in women and older patients. The most common injuries associated with traumatic shock were falls (37.6%) and motor vehicle crashes (18.7%). Mean initial and final medical systolic blood pressure were  $71 \pm 10$  mm Hg and  $99 \pm 24$  mm Hg. Systolic blood pressure increased in 88.8% and decreased or did not change in 11.0%. Mean initial and final trauma systolic blood pressure were  $71 \pm 13$  mm Hg and  $105 \pm 28$  mm Hg; systolic blood pressure increased in 90.4% and decreased/did not change in 9.6%. On fractional polynomial modeling, systolic blood pressure changes were greater and faster for trauma than medical shock.

**24. Jarvis JL, Hamilton V, Taigman M, Brown LH. Using Red Lights and Sirens for Emergency Ambulance Response: How Often are Potentially Life-Saving Interventions Performed? [published online ahead of print, 2020 Jul 17]. Prehosp Emerg Care. 2020;1-13. doi:10.1080/10903127.2020.1797963**

The study objective was to describe the frequency and nature of 9-1-1 calls that result in potentially life-saving interventions during the call. The 2018 ESO research dataset was used for this analysis. Use of lights and sirens, call nature, and interventions performed were evaluated. The definition of potentially life-saving interventions was developed a priori through a consensus process and included both interventions, medications, and critical hospital notifications. The proportion of calls with lights and sirens response as well as with potentially life-saving interventions performed was calculated. The calculation was performed for total calls as well as stratified by call nature. There were 5,977,612 calls from 1,187 agencies included in the analysis. The consensus process identified 42 potentially life-saving interventions. Over 85% of calls utilized lights and sirens, however only 7% resulted in a potentially life saving intervention. cardiac arrest calls had the highest frequency PLSI (45.0%); followed by diabetic problems (37.0%). Glucose was the most frequently given PLSI, n = 69,036. When including multiple administrations to the same patient, epinephrine was given most commonly PLSI, n = 157,282 administrations).

**25. Jarvis J., Johnson B., Crowe R.P. Out-of-hospital Assessment and Treatment of Adults with Atraumatic Headache. JACEP Open. 2020; 1-7.**

The study objective was to describe the out-of-hospital assessment and treatment of adults with benign headache. Meaningful pain reduction stratified by commonly administered medications was also described. ESO data from January 1, 2018 to December 31, 2018 were analyzed. All 911 responses by paramedics for patients 18 and older with headache were included. Patients with trauma, fever, suspected alcohol/drug use, or who received medications suggestive of an alternate condition were excluded. Out-of-hospital pain scores were documented infrequently and less than one in five patients with initial pain scores >5 received medication. Of the 5,977,612 emergency responses, 1.1% (66,235) had a provider documented primary impression of headache or migraine and 52.5% (34,763) met inclusion criteria. An initial pain score was recorded for 73.5% (25,544) of patients, and 58.5% (14,948) of these patients had multiple pain scores documented. Of the patients with multiple pain scores documented, 53.8% (8,037) of patients had an initial pain score >5. Of these, 7.1% (573) were administered any medication. Among patients receiving a single medication, Fentanyl was the most commonly administered (32.1%, 126). As a group, opioids were the most commonly administered class of drugs (38.9%, 153) and were associated with the largest proportion of clinically significant pain reduction (69.3%,106).

**26. Crowe RP, Myers JB, Fernandez AR, Bourn S, McMullan JT. The Cincinnati Prehospital Stroke Scale Compared to Stroke Severity Tools for Large Vessel Occlusion Stroke Prediction. *Prehosp Emerg Care.* 2020 Feb 4:1-15. doi: 10.1080/10903127.2020.1725198.**

The study objective was to determine whether newly-developed LVO stroke scales offer a clinically-meaningful advantage over the Cincinnati Prehospital Stroke Scale (CPSS). ESO Health Data Exchange data from January 1, 2018 and December 31, 2018 was analyzed. CPSS was compared to the Rapid Arterial Occlusion Evaluation (RACE), Los Angeles Motor Scale (LAMS), and the Vision, Aphasia, Neglect (VAN) assessment for LVO prediction. In this large sample of real-world prehospital patient encounters, the CPSS demonstrated similar predictive performance characteristics compared to the RACE, LAMS, and VAN for detecting LVO stroke. There were 13,596 prehospital records with one or more documented stroke scales of interest. Among these, 4,228 patients were diagnosed with stroke. Over half (57%, n=2,415) of patients diagnosed with stroke experienced an acute ischemic stroke. Of patients with ischemic stroke, 26% (n=628) were diagnosed with LVO. A CPSS score of 2 or higher demonstrated sensitivity =69% and specificity =78% for LVO. A RACE score of 4 or higher demonstrated sensitivity =63%, specificity =73%. A LAMS score of 3 or higher demonstrated sensitivity =63%, specificity =72% and a positive VAN score demonstrated sensitivity =86%, specificity =65%. Comparing the area under the ROC curve for each scale revealed no statistically significant differences in discriminative ability for LVO stroke.

**27. Nwanne T., Jarvis J., Barton D., Donnelly J.P., Wang H.E. Advanced airway management success rates in a national cohort of emergency medical services agencies, *Resuscitation*, Volume 146, 2020, Pages 43-49.**

The study objective was to characterize advanced airway management performance in a national cohort of EMS agencies. ESO data from January 1, 2011, to December 31, 2015 were analyzed. Advanced airway management techniques were categorized as conventional endotracheal intubation (cETI), neuromuscular blockade assisted intubation (NMBA-ETI), supraglottic airway (SGA), and cricothyroidotomy (needle and open). AAM success rates varied by airway technique and patient subset. Overall AAM success was 89.1% (95% CI: 88.8-89.3%) across all patients and techniques. Intubation success rates varied by technique; cETI (n=38,004; 76.9%, 95% CI: 76.5-77.3%), NMBA-ETI (n=6768; 89.7%, 88.9-90.4%). SGAs were used both for initial (n=9461, 90.1% success, 95% CI: 89.5-90.7%) and rescue (n=5994, 87.3% success, 95% CI: 86.4-88.1%) AAM. Cricothyroidotomy success rates were low: initial cricothyroidotomy (n=202, 17.3% success, 95% CI: 12.4-23.3%), rescue cricothyroidotomy (n=85, 52.9% success, 95% CI: 41.8-88%). AAM success rates varied by patient subset: cardiac arrest (n=35,782; 91.7%, 95% CI: 91.4-92.0), medical non-arrest (n=17,086; 84.7%, 84.2-85.2%); trauma (n=4341; 84.3%, 83.1-85.3%); pediatric (n=1223; 73.7%, 71.2-76.2%).

**28. Wang H.E., Donnelly J.P., Barton D., Jarvis J. Assessing advanced airway management performance in a National Cohort of Emergency Medical Services Agencies. *Annals of emergency medicine.* 2018 May 1;71(5):597-607.**

The study objective was to assess variations in advanced airway management and conventional intubation performance in a national cohort of EMS agencies. ESO data from January 1, 2011, to December 31, 2015 were analyzed. EMS advanced airway management and initial conventional intubation performance varied widely. During the study period, there were 550 EMS agencies performed 57,209 advanced airway management procedures. Among 401 EMS agencies with greater than or equal to 10 advanced airway management procedures, there were a total of 56,636 procedures. Median reliability-adjusted and risk-standardized EMS agency advanced airway management success was 92.9% (interquartile range 90.1% to 94.8%; minimum 58.2%;

maximum 99.0%). There were 56 advanced airway management low-performing and 38 high-performing EMS agencies. Among 342 agencies with greater than or equal to 10 initial conventional intubations, there were a total of 37,360 initial conventional intubations. Median reliability-adjusted and risk-standardized EMS agency initial conventional intubation success was 77.3% (interquartile range 70.9% to 83.6%; minimum 47.1%; maximum 95.8%). There were 64 initial conventional intubation low-performing and 45 high-performing EMS agencies.

**29. Jarvis, J., Barton, D., Wang, H.E., Defining the Plateau Point: When are further attempts futile in out-of-hospital advanced airway management? Resuscitation, 2018. 130: p. 57-60.**

The study objective was to characterize the number of attempts required to achieve advanced airway management success. ESO data from January 1, 2011 and December 31, 2015 were analyzed. There were 57,209 patients who had at least one Advanced Airway Management attempt included in the analysis. Results indicated that Multiple attempts were often needed to accomplish successful advanced airway management. The number of attempts needed to accomplish advanced airway management varied by advanced airway management technique with cardiac arrest intubation having a success plateau of 4 attempts to reach 91.5% overall success, medical non-arrest intubation having a success plateau of 3 attempts to reach 79.2% overall success, traumatic non-arrest intubation having a success plateau of 3 attempts to reach 75.8% overall success, rapid sequence intubation having a success plateau of 4 attempts to reach 95.8% overall success, sedation-assisted intubation having a success plateau of 3 attempts to reach 85.3% overall success, and supraglottic airways having a success plateau of 3 to reach 92.8% overall success.

**1. Harrell, AL., Rosner, J., Hodges, JB., Crowe, RP., Myers, JB., Fernandez, AR. Evaluating the level of care provided to EMS patients in Virginia when a paramedic was on-scene. The annual meeting of the National Association of State EMS Officials. 2022. Charleston, South Carolina.**

The objective of this study was to evaluate the level of care provided to patients who were treated and transported by Virginia EMS agencies during 9-1-1 responses and intercepts which had a paramedic on-scene. This retrospective study evaluated all EMS events submitted between July 1 and December 31, 2021 to the Virginia EMS Data Repository, provided by ESO. Inclusion criteria were: 1) a response type documented as a 9-1-1 response or intercept, 2) documentation of a paramedic on-scene, 3) successful passage of state data validation (in the NEMSIS 3.4 standard), and 4) a disposition consistent with patient treatment and transport. Each EMS event was then evaluated to determine if a paramedic-level provider was required based on the interventions performed. The top five most frequently documented EMS Provider Primary Impressions were compared among events where a paramedic-only level intervention was performed and those where a paramedic-only level skill was not performed. More than 4 of every 10 EMS transport events where there was a paramedic on scene did not have a paramedic-level intervention performed. There was little difference in providers' primary impressions among events where a paramedic-level intervention was performed and where a paramedic level skill was not performed. 158,257 encounters were found to have a paramedic on-scene and an intervention documented in the prehospital care report and were included in the analysis. Of the records with an intervention reported, 15.5% (24,499) had only BLS- or ALS-level interventions documented.

**2. Messer, MT., Ezzell, D., Mitchell, T., Lewis, C., Emig IV, DA., Crowe, RP., Myers, JB., Fernandez, AR. Describing the impact of paramedic degree requirements in North Carolina. The annual meeting of the National Association of State EMS Officials. 2022. Charleston, South Carolina.**

The objective of this study was to describe the education level of recent graduates of initial paramedic training programs in North Carolina. This retrospective analysis included data from the NC State EMS Data Repository, provided by ESO (Austin, TX). Education levels and demographics for every paramedic student that successfully completed an initial training program and that was currently on an EMS agency roster in NC from January 1, 2020 to December 31, 2021. This statewide analysis of recent paramedic graduates suggests that an important gap between current education practices and the position of leaders in the EMS profession regarding degree requirements. With more than two-thirds of recent graduates not meeting requirements, the cost estimate to those students in NC would be nearly \$2 million. Most currently certified paramedics in NC would not meet the position statements requirements for special certifications, potentially limiting their growth potential EMS. During the study period, there were 1,020 paramedic students that met inclusion criteria. Of those, 85.0% (868) had complete level-of-education data available. Over two-thirds of these students would not currently meet the suggested initial educational requirements: 28% (242) who held a high school diploma or GED and 42% (363) who had some college credits but no degree. Thirty one percent would meet the suggested requirements: 13% with an associate degree and 18% (153) with a bachelor's degree or higher. The median age of those that would not have met the degree requirement was 25 years (IQR: 22 to 31 years). There were about equal numbers of males (48.3% [292])

and females. Over three-quarters (82.3% [498]) of those that would not have met degree requirements had race documented as White, 6.6% (40) were Latino(a), 5.8% (35) were Black, and 5.3% (32) had their race categorized as “other”.

**3. Price, C., Narloch, LB., Fernandez, AR., Nudell, N., Jacobson, KE., Blend, S., Gibbens, B., Eblen, J., Walth, H., Myers, JB., Crowe, RP. Defining a Suite of Performance Measures for Emergency Medical Services (EMS) in Rural Settings: North Dakota Rural EMS Counts Project. The annual meeting of the National Association of State EMS Officials. 2022. Charleston, South Carolina.**

The objective of this study was to define a suite of performance measures relevant to EMS organizations delivering care in rural areas through a systematic review and consensus building process conducted among panels of rural EMS subject matter experts. Through a systematic review of the literature, a modified Delphi approach, and measure development conference, 182 performance measures in 14 categories were defined for rural EMS: airway management, anaphylaxis, asthma/bronchoconstriction, cardiac, cardiac arrest, congestive heart failure/pulmonary edema, global, hypoglycemia, obstetrics/gynecology/neonate/pediatric, pain management, safety, seizures, stroke/transient ischemic attack (TIA), and trauma. For the implementation phase, the project steering committee prioritized five topic areas and selected measures for dissemination via the North Dakota state data platform. The five topic areas were: Cardiac, Stroke, Pain, Vital Sign Assessment, and Safety. All EMS agencies in the state were provided point and click access to all measures within these categories via the ND State EMS Data Repository. Benchmarking at the state and national level was also provided. Further, a baseline index document was created and freely distributed to describe current performance at the state and national levels. This index document further included insights and best practices for improving performance on these key measures. Via the project website, EMS agencies in the state also have access to toolkits for quality improvement to help develop systems of care, workflows and standard operating procedures. Agencies who choose to participate in quality projects related to these prioritized measures are also assigned a subject matter expert to guide improvement efforts.

**4. Lowery, B., D’Acunto, S., Crowe, RP., Fishe, JN. Using Natural Language Processing to Examine Social Determinants of Health in Prehospital Pediatric Encounters and Associations with EMS Transport. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to examine the presence of social determinants of health (SDOH) in EMS clinician free text notes, and quantify the association of SDOH with EMS pediatric transport decisions using natural language processing (NLP). All primary 9-1-1 responses for patients ages 0-17 years from the 2019 ESO Data Collaborative research dataset were included. NLP and an existing corpus were used to extract SDOH categories: income, food, housing, insurance, social support, self-isolation, and child services. We used chi-square tests to determine the univariate association between SDOH categories and transport. There were 325,847 pediatric EMS encounters, of which 35% (n=114,833) were nontransports. Child services (n=2,617) was the most common SDOH factor found in EMS narratives, followed by housing insecurity (1,136). Within the category of self-isolation, self-harm was present in 10,541 narratives. In the multivariable model, child services involvement (OR 2.55 [90% CI 2.29-2.85]), housing insecurity (OR 1.69 [90% CI 1.45-1.98]), insurance security (OR 2.68 [90% CI 2.09-3.44]), poor social support (OR 8.61 [90% CI 1.12-65.09]), and self-harm (OR 4.76 [90% CI 4.41-5.13]) were associated with greater odds of EMS transport. There was no significant association with food insecurity (OR 1.08 [90% CI 0.87-1.36]), or income insecurity (OR 1.42 [90% CI 0.92-2.17]).

**5. Crowe, RP., Kennel, J., Fernandez, AR., Bourn, SS., Burton, B., Van Vleet, L., Wang, HE., Myers, JB. Disparities in Prehospital Analgesia Administration for Trauma Patients With Long Bone Fractures. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to describe prehospital analgesia administration for trauma patients with long bone fractures and identify any differences by patient or encounter characteristics. The 2019 ESO Data Collaborative research dataset was used for this analysis. All adult patients transported by EMS who had an initial prehospital Glasgow Coma Scale score of 15 or AVPU of “alert” and hospital ICD-10 diagnosis codes indicating one or more long bone fractures were included. Encounters from non-paramedic level agencies were excluded. There were 15,150 patients with long bone fractures. Median age was 71 years and 64.5% were female. At least one prehospital pain scale (0-10) was documented for 84.9% (12,855) of patients and the median first pain score was 8 (IQR: 4-10). Prehospital analgesia was administered to 45.4% (6,882) of patients overall. In the adjusted model, Black or African-American patients were 40% less likely to receive analgesia compared to White patients (OR: 0.60, 95% CI: 0.50-0.72). Male patients were 33% less likely to receive prehospital analgesia compared to females (OR: 0.67, 95% CI: 0.60-0.75). For each 10-min increase in EMS transport time, odds of prehospital analgesia increased by 40% (OR: 1.40, 95% CI: 1.32-1.49).

**6. Jones, E., Sergot, P., Crowe, RP., Huebinger, R. Association Between Ketamine Dosing and Outcomes for Patients with Traumatic Injuries. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to evaluate the association between ketamine dosing and adverse outcomes for trauma patients in the prehospital setting. The 2018 and 2019 ESO Data Collaborative research datasets were analyzed. All adult 9-1-1 trauma patients with initial Glasgow Coma Scale (GCS) scores > 8 who received ketamine were included. Of 939 included trauma patients, 72% (675) received guideline dosing (median highest dose: 1.9 mg/kg, interquartile range [IQR]: 1.2-3.8 mg/kg) and 264 received above-guideline dosing (median highest dose: 2.6 mg/kg, IQR: 2.2-5 mg/kg). Above guideline sedation dosing was not associated with greater airway intervention.

**7. Goyal, A., Frawley, J., Chen, N., Gappy, R., Crowe, RP., Swor, R. Prehospital Use of Ketamine Among Pediatric Patients. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to describe patient and encounter characteristics among pediatric emergency medical services (EMS) patients who received ketamine. A secondary objective was to assess effectiveness of ketamine for reducing pain scores among injured patients. The 2019 and 2020 ESO Data Collaborative research datasets were used for this analysis. All 9-1-1 transports of pediatric patients (<18 years of age) who received ketamine were included. In 2019-2020, 1,291 of 422,968 ground-ambulance pediatric patients received ketamine. They were predominately male (842, 65.2%), teenaged (median age 16 years, IQR: 13-17), Caucasian (810, 62.7%), and from urban areas (1041, 80.6%). The most common EMS impressions were related to injuries (810, 62.7%) and behavior disorders (281, 21.8%). Only 980/1291 (75.9%) patients had weight recorded. Most patients (960, 74.4%) received single doses of ketamine, with EMS clinicians reporting improvement in 855 (66.2%). Among nonbehavior patients, 727/1010 (72.0%) had pain scores recorded. Pain scores decreased significantly from mean (SD) 7.0 (3.8) to 3.6 (3.4) ( $p < 0.001$ ). No prehospital deaths were documented.

**8. Owusu-Ansah, S., Crowe, RP., Ramgopal, S. Characteristics and Management of Pediatric Prehospital Asthma. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to describe prehospital treatment of asthma in general for children and to describe whether prehospital treatment of asthma varies by characteristics. The 2019 ESO Data Collaborative research dataset was used for this analysis. All patients 2 to 17 years old with primary complaints of asthma exacerbation were included. Patients with missing documented age, cardiac arrest, nontransports, scene assists, medical category of allergy and anaphylaxis, acute sinusitis, and asphyxiation were excluded. The primary outcomes of interest were prehospital interventions for pediatric asthma management. In total, 6,833 EMS encounters of pediatric patients with suspected asthma or wheezing were included. Bronchodilators were used in 75% of EMS encounters, with 11% of encounters receiving a bronchodilator prior to EMS arrival. Steroids were administered to 3.3%. Compared to White patients, bronchodilator use was increased for Black patients (OR:1.88, 95% CI: 1.55–2.29). Increased odds of bronchodilator use were also noted in the older patients (12–17 yr) relative to younger patients (2–5 yr; (OR:1.71, 95% CI: 1.37–2.14).

**9. Partain, AT., Pack, CE., Miller, ML., Crowe, RP., Brown, LH. 9-1-1 Transport Destination Decisions: Is Patient Choice a Safe Choice? The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to determine if patient choice destinations require greater travel distances and transport times. The 2020 ESO Data Collaborative research dataset was used to identify 9-1-1 scene responses resulting in ground ambulance transport with a reason for destination decision documented. Of the 2,546,928 records included in the analysis, 1,194,979 (48%) listed closest hospital, 1,058,490 (42%) listed patient choice, and 249,662 (10%) cited a specialty facility as the reason for destination decision. Median (interquartile range [IQR]) transport distances were shorter for closest facilities than for patient choice or specialty facilities (3.9 (2.1–7.3) miles vs. 6.0 (3.2–11.5) miles vs. 6.2 (3.1–13.1) miles, respectively,  $p < 0.001$ ). Similar results were seen for median (IQR) transport times: 10 (6–15) min vs. 14 (9–21) min vs. 15 (9–24) min, respectively ( $p < 0.001$ ). Differences between closest and patient choice destinations were more pronounced in nonurban areas (4.3 (2.0–11.7) vs. 16.4 (5.6–27.3) miles; 10 (6–19) vs. 21 (10–33) min,  $p < 0.001$ ). Importantly, patient acuity also differed across the three groups, with lights and sirens rates of 19.2%, 13.4%, and 28.8%, respectively ( $p < 0.001$ ).

**10. Johnson, RC., Crowe, RP., Taigman, M., Jarvis, J., Petrites, S., Hern, G. Racial/Ethnic Disparities in EMS Stroke Assessment and Impressions Among Patients Diagnosed with Stroke. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to compare emergency medical services (EMS) stroke assessment and impressions by patient race/ethnicity. The 2019 ESO Data Collaborative research dataset was used for this analysis. All patients with ED ICD-10 stroke codes were included. Patients who were unresponsive during the EMS encounter (AVPU < V or GCS < 14) were excluded. EMS clinician impressions of stroke or a documented stroke screen were used to define the outcome measure of EMS stroke recognition. There were 9,572 EMS patients with ED stroke diagnoses. More Hispanic patients (26%) had intracranial hemorrhages compared to White (18%) or Black (14%) patients. EMS documented a stroke impression or screen for 58% of White patients, 56% of Black patients, and 48% of Hispanic patients. After adjustment, compared to White patients, the odds of EMS stroke recognition were 19% lower in Black patients (aOR: 0.81, 95% CI: 0.72–0.91) and 32% lower in Hispanic patients (aOR: 0.68, 95% CI: 0.57–0.80).

**11. Frawley, J., Goyal, A., Gappy, R., Chen, N., Crowe, RP., Swor, R. A Comparison of Prehospital Pediatric Analgesic Use of Ketamine and Opioids. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to compare pain control, airway interventions, and mortality for ketamine compared to opioids when used for analgesia among pediatric patients. The 2019 and 2020 ESO Data Collaborative research datasets were used for this analysis. All pediatric patients (<18 years of age) who received ketamine or opioids were included. Patients receiving both medications and those with EMS clinical impressions indicating behavioral disorders were excluded. Primary outcomes of interest were pain score reduction and clinician-documented improvements. Of 422,968 pediatric 9-1-1 patients, 712 (4.7%) received ketamine and 14,552 (95.3%) received an opioid. Average age in both groups was 14 years. Patients who received ketamine were less likely to be injured (73.7% vs. 89.4%,  $p < 0.001$ ). Both ketamine and opioid groups had high rates of improvement following first medication dose (85.3% vs. 87.1%, respectively). Reduction in pain scores for patients receiving ketamine versus opioids. were similar (mean, SD) -3.2 (3.6) vs. -3.1 (2.8),  $p = 0.29$ , respectively. There was a higher rate of ventilatory support (19, 3.0% vs. 11, 0.3%, OR: 41.5, 95% CI:19.6–87.5) in the ketamine group. Advanced airways were more commonly placed in patients who received ketamine compared to opioids, 89 (12.5%) versus 45 (0.3%) (OR: 46.1, 95% CI: 31.9–66.5). EMS narrative review of all cases involving advanced airway placement for both medications revealed 133/134 clear mentions of intentional RSI due to severe illness or injury. There were no deaths in the ketamine group and three deaths (0.02%) in the opioid group.

**12. Farcas, A., Crowe, RP., Gomez, S., Donofrio-Odman, JJ. A Multiagency Comparison of EMS Resuscitation Practices for Pediatric Versus Adult Patients in Cardiac Arrest. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to compare prehospital resuscitation practices and outcomes for pediatric and adult patients with nonshockable out-of-hospital cardiac arrest (OHCA). The 2019 ESO Data Collaborative research dataset was used to this analysis. Only cases where cardiac arrest occurred before EMS arrival, resuscitation was attempted, and the initial rhythm was pulseless electrical activity or asystole were included. Traumatic arrests and responses by basic life support (BLS)-only agencies were excluded. There were 834 pediatric and 5,111 adult OHCA patients analyzed in this study; 91.5% of pediatric patients were transported, compared to 60.1% of adults ( $p < 0.01$ ), with median scene intervals 12.3 (IQR: 6.0–20.0) and 22.5 (IQR: 16.6–30.0) min, respectively ( $p < 0.01$ ). ROSC was achieved in 14.4% of pediatric versus 24.4% of adult patients ( $p < 0.01$ ). Of adult patients, 89.6% received epinephrine, and 5.6% of first epinephrine administrations occurred during transport. Likelihood of receiving epinephrine decreased with younger pediatric age categories (83.7% teens to 51.5% neonates,  $p$ -trend  $< 0.01$ ), while likelihood of first epinephrine during transport increased (38.1% neonates to 9.4% teens,  $p$ -trend  $< 0.01$ ). Univariable odds of ROSC were lower for pediatric (OR: 0.24, 95% CI 0.12–0.49) and adult patients (OR: 0.38, 95% CI 0.26–0.57) when first epinephrine was given in transport versus on scene.

**13. 10. Pack, CE., Partain, AT., Crowe, RP., Brown, LH. Are There Disparities in the Transport Destinations for White and Non-White Patients attended by Emergency Medical Services? The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA**

The study objective was to compare destinations for a broader sample of White and non-White emergency medical services (EMS) patients transported from scenes within the same ZIP code. The 2020 ESO Data Collaborative research dataset was used for this analysis. All 9-1-1 scene

responses resulting in ground transport were included. A masked scene ZIP code variable was used to preserve deidentification. Among 2,914,889 eligible transports from 2,730 ZIP codes, 69.9% (CI: 69.8%–70.0%) of White patients and 62.4% (CI: 62.3%–62.5%) of non-White patients were transported to reference destinations. There are statistically significant and practically meaningful differences in the destination hospitals for White and non-White patients transported by EMS from within the same ZIP code. In the multivariable analysis, White patients remained more likely to be transported to reference destinations than non-Whites (odds ratio 1.22, CI: 1.22–1.23). At the individual ZIP code level, 1,332/2,730 (48.8%, CI: 46.9%–50.7%) ZIP codes had a 5% or greater difference in the proportion of Whites and non-Whites transported to the reference destination; 26.1% (CI: 24.5%–27.8%) of ZIP codes had a 10% or greater difference.

**14. 11. MacAllister, S., Crowe, RP., Smith, M., Fernandez, AR., Bourn, SS., Myers, JB. Prehospital Recognition of Sepsis by EMS Clinicians is Associated with Reduced Patient Mortality. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to describe EMS sepsis recognition and its association with patient mortality. The 2019 ESO Data Collaborative research dataset was used for this analysis. All 9-1-1 records for adult patients (>17 years) with ED ICD-10 diagnosis codes indicating sepsis were included. EMS sepsis recognition was defined as an EMS impression indicating sepsis, use of an EHR sepsis assessment form, or a documented sepsis alert. There were 21,220 patients with any ED sepsis diagnosis attended by 221 EMS agencies. Median age was 71 (IQR: 61–81) years and 50.9% (10,749) were female. EMS recognized 21.5% (4,552) of cases. Fewer than one in four EMS patients with sepsis were identified as such in the prehospital documentation. Among 3,763 patients with septic shock, EMS recognized 23.6% (888). While more EMS-recognized patients presented with abnormal vital signs, prehospital recognition was associated with reduced patient mortality.

**15. Guterma, EL., Burke, JF., Newman, TB., Crowe, RP., Lowenstein, DH., Sporer, KA. Underdosing and Effectiveness of Prehospital Benzodiazepine Treatment for Status Epilepticus. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to examine national prehospital benzodiazepine treatment and the association between midazolam dose, seizure termination, and respiratory failure. The 2019 ESO Data Collaborative research dataset was used for this analysis. All adults with status epilepticus treated with midazolam, lorazepam, or diazepam were included. Patients with cardiac arrest were excluded. There were 9,176 encounters from 743 agencies where midazolam (83.6%), lorazepam (13.8%), or diazepam (2.7%) was administered. Mean age was 46 years (SD 18) and 49.5% (4,526) were female. Initial treatment was discordant with guidelines in 96.1% (8,819 discordant dose or route: 8,562 discordant dose, 5,415 discordant route), and 83.3% (619) of agencies never administered guideline-concordant treatment. For encounters involving midazolam, median intravenous dose was 3 mg (IQR: 2–5; 3,481 encounters), median intramuscular dose was 5 mg (IQR: 5–5; 2,642 encounters), and median intranasal dose was 5 mg (IQR: 3–5; 1,505 encounters). Between-agency variability accounted for 47% of variance in dosing. Rescue therapy was given in 29.4% (2,028) of encounters and ventilatory support in 6.1% (429). Among those receiving midazolam, receiving >5 mg was associated with 8.5% (95% CI 4.9% to 12.0%) absolute decreased risk of rescue therapy and a nonsignificant 0.6% (95% CI 0.7% to 1.9%) risk of ventilatory support. Instrumental variable analyses yielded similar results.

**16. Niederberger, SM., Crowe, RP., Salcido, DD., Menegazzi, JJ. Sodium Bicarbonate Use in EMS-Treated Out-of-Hospital Cardiac Arrest. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to analyze the association of bicarb with resuscitation outcomes in nontraumatic Out-of-Hospital Cardiac Arrest (OHCA). The 2019 and 2020 ESO Data Collaborative research datasets were used for this analysis. All adult patients experiencing cardiac arrest prior to emergency medical services (EMS) arrival in nonhospital settings with resuscitation attempted were included. The analysis was restricted to cases with resuscitation lengths between 5 and 40 min. Prehospital return of spontaneous circulation (ROSC) and survival to hospital discharge were compared by bicarb use status. In total, 51,916 OHCA records were reviewed, of which 47,346 (91.2%) occurred prior to EMS arrival. Of these, 9,503 (20.1%) had shockable initial rhythms, 8,436 (19.4%) had ROSC, and 2,701 (5.7%) survived to discharge. Overall, 15,627 (33.0%) received bicarb, with 2,940 (30.9%) in the shockable and 12,687 (33.5%) in the nonshockable groups ( $p < 0.001$ ). Overall, bicarb administration during shockable OHCA was inversely associated with survival, but was associated with improved survival and ROSC in asystole.

**17. Fernandez, AR., Crowe, RP., Bourn, SS., Myers, JB. National Description of EMS Back-in-Service Time from 2019-2021. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to describe changes in EMS back-in-service intervals from 2019–2021. The ESO Data Collaborative records from 2019–2021 were used in this analysis. Data for 2021 were limited to the first 6 months. Therefore, the study period was limited to the first 6 months of 2019 and 2020 for comparison. All 9-1-1 responses that resulted in patient transport were included. Only EMS agencies with data in the ESO Data Collaborative for all 3 years were included. Over the first 6 months of each year there was a total of 5,904,149 (2019: 2,325,424; 2020: 1,704,247; 2021: 1,876,089) emergency responses among 1,112 agencies. The median back-in-service interval overall was 19.48 (interquartile range [IQR] 12.97–29.13) min. Median back-in-service interval in urban areas (20.08, IQR 13.57–29.55) was 3.08 min longer than in rural areas (17.00, IQR 11.00–27.00). From 2019 to 2021, median back-in-service interval increased by 1.18 min (2019: 18.82, IQR 12.07–28.35; 2020: 19.93, IQR 13.22–29.37; 2021: 20.00, IQR 13.38–29.93). Urban areas saw an increase of 1.35 min (2019: 19.40, IQR 13.22–29.37; 2020: 20.57, IQR 14.00–29.92; 2021: 20.75, IQR 14.07–30.42). Rural areas saw an increase of 0.30 min (2019: 16.70, IQR 10.37–28.00; 2020: 17.02, IQR 11.30–26.65; 2021: 17.00, IQR 11.40–26.73).

**18. Joiner, AP., Cabanas, JG., Crowe, RP., Fernandez, AR., Godfrey, A., Grover, J., Myers, JB., Van Vleet, L., Pavon, J. Differentiating between EMS-Transported and Nontransported Fall Patients: A National Description of Prehospital Falls. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to describe characteristics associated with nontransport among EMS patients encountered for falls. The 2019 ESO Data Collaborative research dataset was used for this analysis. All patients who had 9-1-1 encounters for ground-level falls and were ages 60 years or older were included. Patients residing in congregate living facilities, interfacility transports, cardiac arrests, and suspected drowning patients were excluded. There were 195,204 fall patients in 2019, including 27,563 (14.1%) nontransports. Most patients were female (63.3%), White (85.4%), and fell at home (80.4%). Greater odds of nontransport were identified among males (OR 1.36, 95% CI 1.31–1.41) and Hispanic-Latino patients (OR 1.20, 95% CI 1.11–1.30). Older age was associated with greater odds of nontransport compared to patients ages 60–69 years (70–79 [OR 1.40, 95% CI 1.33–1.47], 80–89 [OR 1.49, 95% CI 1.41–1.57],  $\geq 90$  [OR 1.45, 95% CI 1.35–1.54]).

Patients residing in census tracts with larger percentages of the population living in poverty had lower odds of nontransport compared to those in areas with 25% poverty [OR 0.80, 95% CI 0.74–0.85]).

**19. Sergot, P., Jones, E., Crowe, RP., Huebinger, R. Ketamine Dosing and Association with Outcomes for Patients with Behavioral Emergencies. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to evaluate the effect of prehospital ketamine dosing on outcomes for patients with undifferentiated behavioral emergencies. The 2018 and 2019 ESO Data Collaborative research datasets were used for this analysis. All nontraumatic, adult behavioral and drug-related 9-1-1 EMS encounters where ketamine was given were included. There were 3,271 patients included: 506 in the high dose group (median highest dose 3 mg/kg, IQR 1.8–4.4 mg/kg) and 2,072 in the low dose group (median dose 5 mg/kg, IQR 2.7–5.5 mg/kg). Compared to high dose, the low dose group median age was higher (36 vs. 33.5), fewer patients were White (66.6% vs. 70.1%), and initial median GCS was higher (13 vs. 11). Other characteristics were similar. Patients given ketamine doses above consensus guidelines recommendations for sedation were not more likely to experience worse outcomes.

**20. Lincoln, EW., Crowe, RP., Brown LH. Racial and Ethnic Disparities in Administration of Prehospital Analgesia for Patients with Nontraumatic Abdominal Pain. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to assess prehospital pain assessment and analgesia administration for patients with abdominal pain. The 2019 ESO Data Collaborative research dataset was used for this analysis. All 9-1-1 transports for adult patients (>17 years) with EMS primary impressions of abdominal pain were included. Patients who were pregnant, those with traumatic injuries, and those with initial GCS < 14 were excluded. Responses from basic life support (BLS)-only agencies were also excluded. There were 160,554 records from 1,049 agencies included in this analysis. The median age was 56 (IQR: 40–71) years and 59% were female. Most were White, non-Hispanic (64%), 26% were Black, non-Hispanic, and 8% were Hispanic. At least one pain score was documented in 80% of patients, with similar documentation rates across race/ethnicity categories. Median first pain score among White patients was 6 (IQR:4–9), Black was 8 (IQR:4–10), and Hispanic was 7 (IQR:4–10). Analgesia administration varied across race and ethnicity categories, with White patients receiving analgesia in 14% of cases, Black patients in 9% of cases, and Hispanic patients in 14.5% of cases. After adjustment, compared to White patients, Black patients were 39% less likely to receive pain medication (OR: 0.61, 95% CI: 0.57–0.65). Compared to White patients, there was no difference in analgesia administration in Hispanic patients (OR: 0.98, 95% CI: 0.89–1.07).

**21. Bourn, SS., Fernandez, AR., Crowe, RP., Myers, JB. Are Changes in the Prehospital Rapid Emergency Medicine Score During the EMS Encounter Associated with Changes in Hospital Outcomes. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to determine whether increases in REMS during the EMS encounter are associated with increased rates of hospital admission and overall mortality. The 2019 ESO Data Collaborative research dataset was used for this analysis. All adult patients with ED dispositions who had adequate data to calculate a first and last REMS were included. Patients with no change or decreases in REMS were compared to those with increases during the encounter using univariable odds ratios (OR) and 95% confidence intervals (95% CI). Primary outcomes were hospital admission and overall mortality. In total, 473,977 patients were included in the analysis.

Most (67.1%, 317,968) had no change between initial and final REMS; 20.3% (96,398) had final REMS less than baseline; 12.6% (59,611) had final REMS greater than initial REMS. Odds of hospital admission were 1.4 times higher for patients whose REMS increased (OR 1.39, 95% CI 1.37-1.41) compared to those with no change or reduction. Mortality analysis was performed on 446,958 patients. Overall mortality for patients with stable/improved REMS was 1.3%, compared to 2.6% for patients with increasing REMS, resulting in an odds ratio of 2.01 (95% CI 1.91-2.13).

**22. Hanna, A., Crowe, RP., Fishe, JN. Pediatric Bradycardia is Undertreated in the Prehospital Setting: A Retrospective Multi-Agency Analysis. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to describe the incidence, characteristics, and emergency medical services (EMS) interventions for pediatric patients with bradycardia. The 2019 ESO Data Collaborative research dataset was used for this analysis. All encounters for pediatric patients ages 0-18 were included. Bradycardia was defined as two consecutive EMS-recorded pulse rates that were bradycardic per the 2015 PALS guidelines. We excluded patients who initially presented in cardiac arrest and patients with initial heart rates < 10 as we presumed those to be cardiac arrests. There were 1,209 patients meeting bradycardia criteria. The median age was 2 years (IQR: 0-13), 58.5% of patients were male, 51.1% White, and 28.8% Black. Most (93.6%) responding crews were advanced life support (ALS) units. When considering PALS-recommended treatments, 73% of patients did not receive any oxygen, CPR, atropine, or epinephrine.

**23. Holdaway, JN., Crowe, RP., Bosson, N. Donofrio-Odmann, JJ. Sex and Racial/Ethnic Disparities in Prehospital Care for Patients with ED-Diagnosed STEMI. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to compare prehospital management of patients with emergency department (ED)-diagnosed ST-elevation myocardial infarctions (STEMI) by sex and race/ethnicity. The 2019 and 2020 ESO Data Collaborative research datasets were used for this analysis. All EMS records for patients aged ≥18 years with ED ICD-10 diagnosis of STEMI. Interfacility transfers, cardiac arrest, and non-advanced life support (non-ALS) transports were excluded. Primary outcome was 12-lead electrocardiograph (ECG) acquisition. Secondary outcomes included nitroglycerin administration, opioid analgesia, and age-adjusted mortality. There were 4,891 patients with ED STEMI diagnoses attended by 300 EMS agencies. More male patients (91.4%, 95% CI: 90.4-92.3%) had documented prehospital 12-lead ECGs compared to female patients (88.8%, 95% CI: 87.2-90.2%),  $p < 0.01$ . An interaction between race/ethnicity and sex was identified; Black female patients (86.6%, 95% CI: 81.7-90.4%) had the lowest rate of ECG acquisition compared to White male patients (91.9%, 95.0% CI: 90.7-93.0%),  $p < 0.05$ . Similar patterns were observed for opioid analgesia and nitroglycerin. Opioid analgesia was lowest among Black females (8.8%, 95% CI: 5.8-13.1%) compared to White males (20.3%, 95% CI: 18.7-22.0%),  $p < 0.01$ . Nitroglycerin use was lowest in Hispanic females (34.0%, 95% CI: 25.3-44.0%) compared to White males (51.4%, 95% CI: 49.4-53.5%),  $p < 0.01$ . Age-adjusted mortality was higher in females (11.0%, 95% CI: 9.4-12.5%) compared to males (7.9%, 95% CI: 6.8-8.9%),  $p < 0.01$ .

**24. Niederberger, SM., Crowe, RP., Salcido, DD., Menegazzi, JJ. Sodium Bicarbonate Use in EMS-Witnessed Out-of-Hospital Cardiac Arrest. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to analyze bicarb administration with resuscitation outcomes in EMS-witnessed OHCA. The 2019 and 2020 ESO Data Collaborative research datasets were used for this analysis. All adult patients experiencing EMS-witnessed, nontraumatic cardiac arrest in nonhospital

settings with resuscitation attempted were included. Prehospital return of spontaneous circulation (ROSC) and survival to hospital discharge were compared by bicarb use status. Of 51,916 EMS-treated OHCA in the database, we identified 4,570 (8.8%) EMS-witnessed OHCA. Of these, 680 (14.9%) had initial shockable rhythms, 857 (18.85%) had ROSC, and 354 (7.75%) survived to discharge. Overall, 133 (19.55%) in the shockable and 1,143 (29.38%) in the nonshockable group received bicarb ( $p < 0.001$ ). Overall, bicarb administration during EMS-witnessed nontraumatic OHCA was independently associated with improved survival in shockable presenting rhythms, but was not associated with improved ROSC outcomes in either rhythm group.

**25. Mannion, B., Pirralo, R., Dix, A., Estes, L. The Effect of Prehospital Blood Transfusion on Patient Body Temperature from Time of EMS Transfusion to Arrival at the Emergency Department. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to compare body temperature before and after transfusion of prehospital blood products. Two sources were used for data acquisition: ESO (ESO, Austin, TX) for all prehospital data, and Epic (Epic Systems Corp., Verona, WI) for all ED and inpatient data. Body temperature was obtained upon initial emergency medical services (EMS) evaluation by oral or cutaneous route, and in the ED by oral or rectal route. Two sources were used for data acquisition: ESO (ESO, Austin, TX) for all prehospital data, and Epic (Epic Systems Corp., Verona, WI) for all ED and inpatient data. Body temperature was obtained upon initial emergency medical services (EMS) evaluation by oral or cutaneous route, and in the ED by oral or rectal route. Forty-nine consecutive patients were analyzed: 31 males and 18 females; mean age was 57 years. Reason for transfusion included 13 traumatic hemorrhages and 36 medical indications, with gastrointestinal (GI) bleed being most common (43%). Most patients (80%) received 2 units pRBC (maximum 4 units); 59% of patients also received FFP. Initial EMS pretransfusion body temperatures were compared with initial ED temperatures. A paired, two-tailed t-test demonstrated a statistically significant difference in body temperature pre transfusion and upon ED assessment ( $t=2.806$ ,  $p=0.007$ ). Although a statistically significant difference in body temperature following blood transfusion occurred in this cohort, there was found to be a clinically insignificant difference between the means of these two groups ( $0.8^{\circ}\text{F}$ ).

**26. Miller, ML., Partain, AT., Watanabe, BL., Crowe, RP., Brown, LH. Heterogeneity Among Patients with Behavioral Emergencies Requiring Emergent Sedation. The annual meeting of the National Association of Emergency Medical Service Physicians. 2022. San Diego, CA.**

The study objective was to determine if demographics, clinical presentations, and hospital diagnoses differed across three types of behavioral-related presentations. The 2019 ESO Data Collaborative research dataset was used for this analysis. All paramedic-attended 9-1-1 scene responses to patients with behavioral manifestations, combativeness (from uncooperativeness to frank violence), or a combination of both, who required emergent sedation were included. Patients with conditions that potentially mimic behavioral emergencies (e.g., hypoglycemia, head injury) were excluded. Of 8,360 patients receiving emergent sedation, 2,003 (24%) presented with behavioral manifestations alone, 1,638 (20%) with combativeness alone, and 4,719 (56%) with both. Patients with combativeness alone were more likely than patients with behavioral manifestations alone or a combination of the two to be male (73% [CI: 71–75%] vs. 56% [CI: 55–58%]), be injured (20% [CI: 18–22%] vs. 14% [CI: 13–15%]), or have altered mental status (16% [CI: 14–18%] vs. 6% [CI: 6–7%]). Patients with behavioral manifestations alone were more likely than those with any combativeness to be tachypneic (27% [CI: 25–29%] vs. 19% [CI: 18–20%]), tachycardic (37% [CI: 35–39%] vs. 26% [CI: 25–27%]), or hypertensive (9% [CI: 8–11%] vs. 6% [CI: 5–6%]). Diagnosis data

were available for 2,220 (27%) patients. A mental health diagnosis was less likely among patients presenting with combativeness alone (64% [CI: 60–69%]) compared with specific behavioral manifestations alone (77% [CI: 73–80%]) or a combination of both (74%, [CI: 71–76%])

**27. Gage, C., Deziel, JD., Wilfong, JA., Sensitivity and Specificity of Emergency Medical Dispatching Protocols in the United States. Prehospital Care Research Forum International Scientific Symposium at EMS World Expo 2021. Atlanta, GA**

The study objective was to evaluate the sensitivity and specificity of emergency medical dispatch (EMD) protocols in the United States. The 2019 ESO Data Collaborative research dataset was analyzed to determine the sensitivity and specificity of multiple variables when the ambulance was dispatched with lights/sirens compared to no lights/sirens. The results showed that 87% of all 9-1-1 calls were dispatched with an ambulance using lights/sirens when traveling to the patient, and 86% of the patients transported were transported with no lights/sirens. When comparing the use of lights/sirens upon dispatch to their use during transport, EMDs had a positive predictive value of 15.61% and a negative predictive value of 97.86%. The lights/sirens transport results suggest patients are generally sicker than those without lights/sirens transports.

**28. Fernandez, AR., Crowe, RP., Bourn, S., Myers, B. Minimum Vital Sign Set Documentation Among 9-1-1 Patients Not Transported By EMS. Prehospital Care Research Forum International Scientific Symposium at EMS World Expo 2021. Atlanta, GA**

The study objective was to describe documentation of a minimum set of vital signs and associated factors among 9-1-1 events in which the patient was not transported by EMS. Data were obtained from the ESO Data Collaborative for calendar year 2020. All 9-1-1 responses for adults (age  $\geq 18$  years) not transported by EMS were included. Nontransports were excluded if the EMS disposition indicated the patient refused evaluation or treatment. A minimum set of vital signs was defined as documentation of heart rate, respiratory rate, and systolic blood pressure. Of 8,296,774 total 9-1-1 events, 11.6% (980,199) involved adult patients not transported by EMS. A minimum set of vital signs was documented for 77.0% (754,787). Compared to patients ages 18–30 years, patients in every other decade of life had increased odds of minimum vital sign set documentation. Odds were decreased for males (OR=0.88; 95% CI: 0.88–0.89). Compared to patients with race/ethnicity categorized as white, Black patients (OR =1.58; 95% CI: 1.56–1.60), Hispanic patients (OR=1.17; 95% CI: 1.14–1.19), and patients categorized as other (OR=1.20; 95% CI: 1.15–1.25) had increased odds. EMS encounters in rural areas saw a 44% reduction in the odds of minimum vital sign set documentation (OR=0.56; 95% CI: 0.55–0.56).

**29. Fernandez, AR., Crowe, RP., Bourn, S., Myers, B. Evaluating Prehospital Use of Personal Protective Equipment During the COVID-19 Pandemic. Prehospital Care Research Forum International Scientific Symposium at EMS World Expo 2020 and The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to describe the use and reuse of PPE among EMS providers during the COVID-19 pandemic. All 9-1-1 records from the national ESO Data Collaborative from March 5–June 15, 2020 with a documented EMS provider primary or secondary impression indicating COVID-19 were included. PPE was considered to have been used during the encounter if any of the above-mentioned PPE articles were documented for at least one EMS provider listed on the prehospital care record. There were 34,984 records with a COVID-19 impression documented. Of those, 15% (5,263) did not have PPE documented. Among the 29,721 records with documented PPE, a mask (N95, surgical mask, or PAPR) was documented on 89% (26,529) of records. Of those, 82% (24,469) had documented N95 use, of which 42% (10,290) indicated reuse. Another 17% (5,261) recorded use of surgical masks, of which 42% (2,220) indicated reuse. PAPR use was

documented on 3% (967) of records. Face shield use was documented on 19% of records (5,537), of which 37% (2,027) indicated reuse. Finally, eye protection was documented on 88% (26,175) of records with documented PPE.

**30. Harris, M; Fische, J; Crowe, R; D'Acunto, S; Adelgais, K; Anders, J. Applying a Set of Termination of Resuscitation Criteria to Pediatric Out-of-hospital Cardiac Arrest. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to apply a set of pediatric Termination of Resuscitation (pTOR) criteria in a large national cohort and examine the test characteristics associated with its accuracy in predicting return of spontaneous circulation (ROSC) after pediatric out of hospital cardiac arrest (POHCA). Data were obtained from the ESO Data Collaborative from January 1, 2019 to December 31, 2019. Patients ages 0-18 treated by EMS with cardiac arrest were included. Those suffering from traumatic cardiac arrest were excluded. The Maryland criteria allows for consideration of pTOR after medical POHCA for patients 0-17 years with asystole after 30 minutes of resuscitative efforts on scene, the administration of epinephrine, and an end-tidal CO<sub>2</sub><15 mmHg. A total of 1,762 patients were evaluated, with 1,475 meeting inclusion criteria. The Maryland pTOR rule was highly specific (99% specificity, 4% sensitivity, Positive Predictive Value 96%, and Negative Predictive Value 24%), although 2 patients who achieved ROSC would have met the criteria for termination of resuscitation.

**31. Rodriguez, E; Baade, H; Crowe, R; Myers, B; Wampler, D. Measuring the Overuse of Helicopter Air Ambulances for Transport of Trauma Patients. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to measure the over-triage rate in Helicopter air ambulance (HAA) use for trauma transport. All 9-1-1 records from the national ESO Data Collaborative from January 1, 2018 to December 31, 2018 were included. Major trauma activation criteria were defined using available discrete data elements: systolic blood pressure<90 mmHg; respiratory rate<10 or>29; GCS<14; penetrating wound to head, neck, or torso; amputation; or pelvis injury. The validated Rapid Emergency Medicine Score (REMS) was used to evaluate baseline prehospital patient acuity. There were 691,901 trauma responses in the study period and 1% (5,984) were transported by HAA. No major trauma activation criteria were documented for 57% (3,448) of HAA patients. The median initial prehospital REMS score for patients transported by HAA without documented trauma activation criteria was 3 (IQR: 2-6) compared to 7 (IQR: 4-10) among HAA patients with at least one criterion (p<0.001). -in-3 HAA transports without activation criteria originated in urban settings, suggesting time savings may have been limited.

**32. Crowe, RP., Bourn, S., Fernandez, AR., Myers, B. Initial Prehospital Rapid Emergency Medicine Score to Predict Emergency Department and Hospital Dispositions of EMS Patients. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to assess predictive characteristics of initial prehospital Rapid Emergency Medicine Score (REMS) for ED and hospital dispositions. This retrospective analysis used linked prehospital and Health Data Exchange data from the ESO Data Collaborative from January 1, 2019 to December 31, 2019. Initial REMS (0-26) was calculated using age, pulse rate, mean arterial pressure, respiratory rate, oxygen saturation, and Glasgow Coma Scale. Patients<18 and cardiac arrests prior to EMS arrival were excluded. Overall, 62%(n=304,234) of patients were discharged from the ED, 36% (n=178,600) were admitted, 2% (n=10,697) were transferred, and 0.2% (n=960) died in the ED. Median REMS of discharged patients was 5 compared to 7 among admissions and 11 among patients who died in the ED (p<0.01). A REMS cut-point of >5

demonstrated optimal statistical prediction for admission or ED mortality (AUROC:0.69). REMS>5 demonstrated a three-fold increase in odds of admission or ED mortality (OR: 3.28, 95%CI: 3.24-3.32). Median REMS for discharged patients was 7 and 9 for patients who died. Among admitted patients, initial prehospital REMS>5 was associated with a 3-fold increase in odds of hospital mortality (OR:3.02, 95%CI:2.81-3.24).

**33. Crowe, R; Pepe, P; Fernandez, AR; Bourn, S; Manifold, C; Myers, B. Comparison of Benzodiazepines, Ketamine and Antipsychotics for Prehospital Sedation of Patients Experiencing Behavioral Health Emergencies with Combativeness. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to compare the relative safety of benzodiazepines, ketamine and antipsychotics among patients experiencing out-of-hospital behavioral emergencies with combativeness (BHE-C) using a large nationwide database. A retrospective 2019 calendar year analysis of BHE-C records from the ESO Data Collaborative was performed including subsets of records with linked Health Data Exchange emergency department (ED) and hospital outcomes. BHE-C patients were identified by EMS impression and/or documented signs/symptoms. Prehospital sedation was defined as intramuscular or intranasal administration of a benzodiazepine, ketamine, or an antipsychotic as the first medication provided. Outcomes included prehospital noninvasive positive pressure ventilation (NIPPV), advanced airway placement, and ED/hospital disposition. Fewer than 1 in 5 patients experiencing BHE-C received prehospital sedation and benzodiazepines were used most frequently. Ketamine was associated with more ventilation and advanced airway assistance, but no differences were observed with regard to in-hospital deaths and no deaths occurred in the prehospital or ED settings.

**34. Walter, D; Chan, HK; Crowe, R; Osborn, L; Jarvis, J; Wang, H. Effect of Prehospital Noninvasive Positive Pressure Ventilation for Rescue of Acute Dyspnea. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to characterize the association of out-of-hospital noninvasive positive pressure ventilation (NIPPV) with improvement of dyspnea in a national EMS cohort. Data were obtained from the ESO Data Collaborative from January to December 2018. Acute dyspnea was defined as adults (age≥18 years) with initial respiratory rate (RR) ≥30 breaths/minute (bpm) and EMS clinical impression of respiratory emergency. The primary outcome was change in RR, censored at 90 minutes of treatment. Of the 5,172,504 adult 911 responses, 33,585 were included with acute dyspnea, including 8,750 (26.1%) NIPPV and 24,835 (73.9%) non-NIPPV. In this multicenter series of out-of-hospital acute dyspnea, NIPPV was not associated with improved RR. Median treatment durations were: NIPPV 23.3min (IQR 16.5-32.1), non-NIPPV 23.6 min (IQR 16.3-32.8).

**35. Huebinger,R; Stilgenbauer, H; Jarvis, J; Ostermayer, D; Schulz, K; Wang, H. Video Laryngoscopy for Out-of-Hospital Cardiac Arrest. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to evaluate the association between video laryngoscopy (VL) with first pass success and ROSC. This study used the data from January 1, 2018 to December 31, 2018 obtained from the ESO Data Collaborative. All patients ≥18 years of age were included. Compared to direct laryngoscopy (DL), VL had a lower rate of bystander CPR (41.4% v 36.1%, p<.001), but other characteristics were similar between the groups. VL had a higher first pass success rate than DL (75.1% v 69.5%, p<.001). Using a mixed model analysis, VL was associated with a higher rate of first pass success (OR 1.5, CI 1.3-1.6), but VL was not associated with improvement in ROSC (OR 1.1, CI 0.97-1.2) or sustained ROSC (OR 1.1, CI 0.9-1.2).

**36. Dean, B; Crowe, R; Fernandez, AR; Bourn, S; Myers, B. Initial Prehospital Glasgow Coma Scale and its Components to Predict Mortality among Trauma Patients. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to assess predictive performance of initial prehospital GCS and its components for mortality among trauma patients. This was a retrospective analysis of 911 records for adult trauma patients from 1/1/2019-12/31/2019 and hospital disposition within the ESO Data Collaborative. Patients with penetrating trauma were excluded. Receiver operating curves for total GCS, the eye component (GCSe), verbal component (GCSv) and motor component (GCSm) were constructed and area under these curves (AUROC) was measured to compare predictive values of the GCS and its components for mortality. AUROC for total GCS was 0.74 (95%CI: 0.72-0.76), 0.67 (0.65-0.69) for GCSe, 0.73 (0.72-0.75) for GCSv and 0.69 (0.67-0.70) for GCSm. Initial prehospital GCSm and GCSe components demonstrated similar predictive characteristics for mortality compared to total GCS. The use of these two simplified components of the GCS may be a prehospital tool to identify patients with increased mortality risk.

**37. Ashburn, N; Snavelly, A; Scheidler, J; Angi, R; Crowe, R; McGinnis, H; Hiestand, B; Miller, C; Mahler, S; Stopyra, J. Disparities in Emergency Medical Services Times for Rural Patients with Acute Cardiac Complaints. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to quantify rural and urban differences in EMS time intervals for patients with cardiac problems. The ESO Data Collaborative was queried for 911 calls with an impression or chief complaint of a cardiac problem among adults (age $\geq$ 18) from 1/1/2013-6/1/2018. The primary outcome was total prehospital time, defined as dispatch to hospital arrival. Secondary outcomes included response time (dispatch to scene arrival), scene time (scene arrival to depart scene), and transport time (depart scene to hospital arrival). The median total prehospital, response, scene, and transport times were 36 (IQR 28-47), 5 (IQR 3-9), 16 (IQR 12-21), and 13 (IQR 8-20) minutes, respectively. After adjusting for age, sex, race, response priority, and stability, the total prehospital time on average was 16.22 (95%CI 14.61-17.82) minutes longer for rural patients than urban patients. Similarly, on average response time was 5.32 (95%CI 4.76-5.87) minutes longer, scene time 0.45 (95%CI 0.22-0.69) minutes longer, and transport time 10.57 (95%CI 9.34-11.79) minutes longer for rural patients.

**38. Miller, M; Watanabe, B; Brown, L. Are there gender or racial disparities in EMS-administered sedation among patients in police custody? The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to explore whether racial disparities exist in the frequency of EMS-administered sedation for patients in police custody. This study used the data from January 1, 2018 to December 31, 2018 obtained from the ESO Data Collaborative. Inclusion criteria were: (1) EMS requested by police; (2) response by a paramedic level agency; and (3) scene, transport or disposition data suggesting the patient was in custody or otherwise under police control. Additionally, sedation in the subset of patients with a chief complaint, primary impression, secondary impression, treatment protocol, or barrier to care entry presumptively suggesting the patient was combative were explored. Sedation was defined as documented administration of ketamine, lorazepam, midazolam, propofol, haloperidol or droperidol. There were 50,542 law enforcement requests for EMS response for in-custody patients that were attended by a paramedic level agency. There were 532 (1.1%) instances of sedation. The proportion of in-custody males and females who received sedation was similar, (1.2% vs.1.0%,  $p=0.116$ ), as were the proportions of White (1.2%), Black (1.1%) and Hispanic (1.0%) patients ( $p=0.330$ ). There were

11,007 (22%) responses involving presumptively combative patients, with 289 (2.6%) receiving sedation. The lack of association between race/ethnicity and sedation persisted in the subset of combative patients ( $p=0.779$ ), but combative male patients were more likely than combative female patients to receive sedation (3.1% vs. 1.8%,  $p<0.001$ ).

**39. Miller, M; Watanabe, B; Robinson, E; Brown, L. Evaluating the Efficacy and Safety of Ketamine Administration for Prehospital Pain Control. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to explore the efficacy and safety of ketamine, in comparison with morphine and fentanyl, when used solely for analgesia in isolated, non-cardiorespiratory painful conditions. This study used the data from January 1, 2018 to December 31, 2018 obtained from the ESO Data Collaborative. Inclusion criteria were: a 911 scene response; age $\geq$ 18 years; an initial complaint or use of a treatment protocol indicating a painful condition; prehospital administration of ketamine, fentanyl or morphine; and first and last pain scale and GCS data available. Patients were excluded if they received a combination of medications, or if there were indications medication administration could have been for airway management or agitation control. In pairwise comparisons, all three groups differed from each other (all  $p<0.001$ ). Most patients had no change in GCS, but ketamine more often reduced GCS by 2 or more points ( $n=100$ , 9.5%) than fentanyl ( $n=112$ , 0.2%) or morphine ( $n=19$ , 0.2%), and the distributions of GCS changes differed across the three groups ( $p<0.001$ ). In pairwise comparisons, ketamine decreased GCS more than fentanyl ( $p<0.001$ ) and morphine ( $p<0.001$ ); GCS changes did not differ for the morphine and fentanyl groups ( $p=0.721$ ).

**40. Fernandez, AR; Crowe, R; Bourn, S; Myers, B. National Description of Prehospital Ketamine Administration including Patient Outcomes.**

The study objective was to describe prehospital ketamine administration and patient outcomes using a large national database. This retrospective observational study included all 9-1-1 responses, from the national ESO Data Collaborative, with prehospital ketamine administration for all patients, except cardiac arrest prior to EMS arrival, from 1/1/2019 to 12/31/2019. Hospital outcomes were obtained from ESO Health Data Exchange data. There were 15,204 prehospital ketamine administrations among 11,291 patients. Median total dose was 100mg (interquartile range: 35-300mg). EMS-PIs were 49% (5,575) pain/trauma, 34% (3,795) AMS, 13% (1,454) TCI, 2% (248) seizure, and 2% (219) other. Greater than 99% (11,274) were transports/assists/transfers of care to other EMS, <1% were released on scene (9) or dead on scene (8). There were 18% (2,030) with linked ED dispositions. Among those, 53% (1,068) were admitted, 40% (822) were discharged from the ED, 5% (92) transferred, 2% (34) expired in the ED, and <1% (14) AMA. Mortality status was unknown at the end of the study period for 7% (152). Of the 93% (1,878) with known mortality status, 94% (1,757) were alive and 6% (121) died. One death was excluded because physician review revealed that ketamine was never administered. Among those who had an advanced airway, 30% (46) died. Physician review determined ketamine could not be excluded as a contributing factor to death in 0.3% (6/1,878).

**41. Harris, M; Crowe, R; D'Acunto, S; Anders, J; Adalgais, K; Fishe, J. Combining traditional biostatistical analysis with natural language processing to identify new factors associated with Return of Spontaneous Circulation after Pediatric Out of Hospital Cardiac Arrest. The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to use natural language processing (NLP) analysis of the EMS narrative and standard biostatistics in a large national EMS database and examine factors associated with

prehospital return of spontaneous circulation (ROSC) in Pediatric out-of-hospital cardiac arrests (POHCA). This study used the data from January 1, 2019 to December 31, 2019 obtained from the ESO Data Collaborative for patients 0-18 years of age. There were 1,825 episodes of POHCA. ROSC after POHCA is associated with having an EMS-witnessed arrest and an initial shockable EKG rhythm. EMS notes reveal additional clues to potential futile resuscitations such as rigor and lividity.

**42. Crowe, RP., Fernandez, AR., Bourn, S., Myers, B. Assessing the Impact of the COVID-19 Pandemic on EMS Transport Patterns for Patients with Suspected Acute Coronary Syndrome. Oral presentation at the Prehospital Care Research Forum International Scientific Symposium at EMS World Expo 2020 and The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to describe changes in EMS use and transport patterns for patients with suspected ACS during the COVID-19 pandemic compared to a control period one year prior. This retrospective analysis used prehospital records from the ESO Data Collaborative. The authors compared responses for patients with suspected ACS from the first three months of the pandemic (study period: March 1–May 31, 2020) to the previous year (control period: March 1–May 31, 2019). Only agencies contributing records in both time periods were included. Total 9-1-1 call volume decreased 5% between the control period (1,131,399) and study period (1,071,868). Nontransports increased from 17% to 19% of all encounters ( $p < 0.001$ ). Total encounters for suspected ACS decreased by 16% (67,697 to 56,969). Suspected ACS encounters resulting in nontransport increased from 6% to 9% ( $p < 0.001$ ). Controlling for age and race/ethnicity, females with suspected ACS were less likely to be transported in the study period (aOR 0.76, 95% CI 0.72–0.81) and control period (0.81, 0.75–0.94) compared to males. Compared to white non-Hispanic patients, Hispanic patients were less likely to be transported during the study period (0.82, 0.74–0.91) and control period (0.84, 0.75–0.94). Black non-Hispanic patients were less likely to be transported during the study period only (0.91, 0.84–0.97).

**43. Fernandez, AR., Myers, B., Crowe, RP., Bourn, S., Mills, M. A Descriptive Assessment of Prehospital Ketamine Administration Using a Statewide Data Repository. Poster presentation at the Prehospital Care Research Forum International Scientific Symposium at EMS World Expo 2020 and The annual meeting of the National Association of Emergency Medical Service Physicians. 2021. Virtual.**

The study objective was to describe patients who received prehospital ketamine in West Virginia. ESO state repository data was used for this analysis. The study included all West Virginia 9-1-1 patients who received prehospital ketamine from Jan. 1–Dec. 31, 2019. West Virginia protocols allow ketamine administration for pain and excited delirium. EMS provider impressions were categorized as pain/injury, altered mental status (AMS)/behavioral, and other. In 2019 there were 154,906 West Virginia 9-1-1 patients, and 173 (0.1%) received prehospital ketamine. In all, 62% (74) of patients with pain/injury impressions, 33% (40) with AMS/behavioral, and 6% (7) with other received ketamine. Ketamine for pain/injury was administered more often in rural areas, while ketamine for AMS/behavioral impressions was more frequent in urban areas. Those with pain/injury were older than those with AMS/behavioral impressions.

**44. Fernandez, AR., Crowe, RP., Bourn, S., Myers, B. A Comparison of EMS Patients Diagnosed with COVID-19 Before and After Reopening in the United States of America. Oral presentation at the Prehospital Care Research Forum International Scientific Symposium at EMS World Expo 2020.**

The study objective was to compare EMS encounter and demographic characteristics of patients diagnosed with COVID-19 before and after the first reopening. All 9-1-1 patients from the national

ESO Data Collaborative who had a hospital ICD-10 diagnosis of COVID-19 were included. For the analysis, March 15–April 30, 2020, represented “before reopening”; May 1–June 15, 2020, represented “after reopening.” There were 1,844 COVID-19-diagnosed 9-1-1 patients before reopening and 1,765 after reopening. The median age before reopening (69; interquartile range [IQR] 55–81) was significantly ( $p < 0.01$ ) higher than after reopening (64.5; IRQ 50–78). More patients were less than 40 years old after reopening (18%, 326 vs. 24%, 421,  $p < 0.001$ ). EMS patients diagnosed with COVID-19 were younger after the easing of stay-at-home orders. Also after reopening, more patients were reported to be Hispanic/Latino or other race, and slightly more patients were transported from homes/residences and healthcare facilities.

**45. Robinson, E.J., Watanabe, B., Brown, L.H. Prehospital Ketamine Administration for Pain Control Does Not Prolong Emergency Department Length of Stay. The annual meeting of the Society for Academic Emergency Medicine. 2020. Virtual Meeting**

The study objective was to compare ED length of stay among EMS patients who received prehospital ketamine, fentanyl or morphine specifically for pain control. The 2018 ESO research dataset was used for this analysis. There were 10,493 patients that met inclusion criteria. Of those, 131 received ketamine, 8,809 received fentanyl, and 1,553 received morphine. Median (IQR) ED length of stay was 3.6 (2.6-6.1) hours for patients who received ketamine, 3.8 (2.7-5.5) hours for patients who received fentanyl, and 4.1 (2.7-6.2) hours for patients who received morphine ( $p < 0.001$ ). In post-hoc pairwise comparisons, patients who received morphine had significantly longer ED length of stay than patients who received fentanyl ( $p < 0.001$ ); there was no significant difference in ED length of stay for patients who received ketamine vs. morphine ( $p = 0.131$ ), or for patients who received ketamine vs. fentanyl ( $p = 0.875$ ).

**46. Houston, S., Dean, B., Taylor, S., Howell, S., Cornelius, C. Pediatric CARE (Cardiac Arrest Resuscitation by EMS). ESO Wave 2020. 2020. Austin, TX.**

The study objective was to examine the effect of determinants on the likelihood of achieving return of spontaneous circulation in pediatric out-of-hospital cardiac arrest. The ESO 2017 Research Dataset was used for this analysis. Witnessed arrests were more likely to achieve return of spontaneous circulation. CPR feedback devices showed statistical significance in achieving return of spontaneous circulation in pediatric out-of-hospital cardiac arrest when utilized. Caucasian pediatric out-of-hospital cardiac arrest and early epinephrine administration also improved the likelihood of return of spontaneous circulation.

**47. Moore, A., Clemency, B.M., Brown, L.H., Vital Signs Are an Effective Predictor of EMS-witnessed Cardiac Arrest. ESO Wave 2020. 2020. Austin, TX.**

The study objective was to explore whether an existing vital signs-based risk assessment score or a simple count of abnormal vital signs (level of consciousness; heart rate; respiratory rate; systolic blood pressure) can identify patients at risk for EMS-witnessed arrest. The ESO 2018 Research Dataset was used for this analysis. This study compared the ability of the Modified Early Warning Score (based on first recorded vital signs, excluding temperature) and the count of abnormal first recorded vital signs to differentiate adult non-traumatic EMS-witnessed arrest patients from non-arrest but emergently transported patients. Vital sign-based assessments can help identify patients at risk for EMS-witnessed arrest. The absence of at least 3 normal vital signs indicates increased risk of EMS-witnessed arrest. The study found that using the count of abnormal vital signs sacrifices some sensitivity but is easier than calculating the Modified Early Warning Score.

**48. Crowe, R.P., Myers, B., Fernandez, A.R., Bourn, S. McMullan, J.T. Prehospital Performance of the Cincinnati Prehospital Stroke Scale Compared to LVO-specific Instruments for Identifying LVO Stroke. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to determine whether newly-developed LVO stroke scales offer a clinically-meaningful advantage over the Cincinnati Prehospital Stroke Scale (CPSS). The 2018 ESO Health Data Exchange research dataset was used for this analysis. CPSS was compared to the Rapid Arterial Occlusion Evaluation (RACE), Los Angeles Motor Scale (LAMS), and the Vision, Aphasia, Neglect (VAN) assessment for LVO prediction. In this large sample of real-world prehospital patient encounters, the CPSS demonstrated similar predictive performance characteristics compared to the RACE, LAMS, and VAN for detecting LVO stroke.

**49. Crowe, R.P., Myers, B., Fernandez, A.R., Myronenko, V., Bourn, S. McMullan, J.T. Factors Associated with Failure to Document a Prehospital Stroke Screen in Patients Diagnosed with Stroke/TIA. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to describe factors associated with reduced likelihood of EMS documenting a stroke screen among a cohort of patients diagnosed with stroke. The 2018 ESO Health Data Exchange research dataset was used for this analysis. Of 13,323 patients with hospital diagnosed stroke/TIA, 51% (n = 6,824) were acute ischemic stroke (AIS), 24% were nontraumatic intracranial hemorrhages (ICH) (n = 3,236), 19% were TIA (n = 2,572), and 5% involved multiple stroke types (n = 691). Approximately one-third of EMS patients with hospital-diagnosed stroke/TIA did not have a prehospital stroke screen documented. Younger age, ICH, and presence of injury were associated with reduced odds of stroke screen documentation.

**50. Crowe, R.P., Fernandez, A.R., Schroeder R., Bourn, S., Myers, B. Evaluating the Utility of Prehospital Shock Index and Modified Shock Index to Predict Hospital Sepsis and Septic Shock Diagnosis. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to evaluate initial prehospital Shock Index (SI), Modified Shock Index (MSI), and Systolic Blood Pressure (SBP) as predictors of hospital sepsis/septic shock diagnosis. The 2018 ESO Health Data Exchange research dataset was used for this analysis. Elevated initial prehospital SI and MSI demonstrated stronger associations with sepsis diagnosis compared to SBP < 90 in this population.

**51. Fernandez, A.R., Crowe, R.P., Bourn, S., Myers, B. Prehospital Recognition of Patients Diagnosed with Sepsis and Septic Shock. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to estimate EMS sepsis recognition and describe prehospital characteristics of patients diagnosed with sepsis/septic shock. The 2018 ESO Health Data Exchange research database was used for this analysis. There were 325,558 adult non-trauma patients with linked EMS-hospital records, 16,881 (5.2%) were diagnosed with sepsis. Of these, 18.6% (3,144/16,881) were diagnosed with septic shock. Sepsis and septic shock patient vital signs were consistent with their diagnosis. Prehospital temperature was not documented consistently. Sepsis/Septicemia was infrequently documented as the primary or secondary impression.

**52. Fernandez, A.R., Crowe, R.P., Bourn, S., Myers, B. Variation in Use of Lights and Sirens for Patient Transport: A National, Agency-Level Comparison. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to describe variability in L&S use for scene-to-hospital 9-1-1 transports among a national cohort of EMS agencies. The 2018 ESO research dataset was used for this analysis. There were 1,190 EMS agencies analyzed, representing 3,634,564 scene-to-hospital transports that met inclusion criteria. Overall, 13.8% (499,714/3,632,564) of 9-1-1 patients were transported using lights and sirens. Almost half of EMS agencies used lights and sirens for 10% or less of scene-to-hospital 9-1-1 patient transports. Nevertheless, approximately 1 out of 8 agencies had documented lights and sirens use for more than 50% of transports.

**53. Jarvis, J., Johnson, B., Crowe, R.P. Prehospital Epidemiology and Treatment of Patients with Atraumatic Headache. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to describe the epidemiology and treatment of prehospital atraumatic headaches in adults. The secondary objective was to describe meaningful pain reduction by commonly administered medications. The 2018 ESO research dataset was used for this analysis. Of the 5,977,612 emergency responses, 66,235 (1.1%) had an impression of headache/migraine and 34,763 (52.5%) met inclusion criteria. Prehospital pain scores were documented infrequently. Less than one-fifth of patients with initial pain scores >5 received medication.

**54. Escott, M.E., Crowe, R.P., Brown, L. An Epidemiological Description of Traumatic Out-of-Hospital Cardiac Arrest. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to describe EMS encounters for traumatic out-of-hospital cardiac arrests (Tr-OOHCA) among a nationwide cohort of EMS systems, and identify factors associated with return of spontaneous circulation (ROSC) and survival. The 2018 ESO research dataset was used for this analysis. ROSC was documented in 19.9% of cases. In this large US-based dataset, resuscitation of Tr-OOHCA was not futile, with ROSC and survival rates similar to those for all-rhythm medical OOHCA. Although ROSC appears more likely in some patient subgroups, no demographic or clinical Tr-OOHCA subgroup had ROSC rates near zero.

**55. Stopyra, J., Crowe, R.P., Snively, A., Page, N., Ashburn, N., Foley, K., Miller, C., Mahler, S. Rural Health Time to Care Disparities for Prehospital Patients with Suspected STEMI. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to compare rural vs. urban time intervals among a national cohort of prehospital patients with suspected STEMI. The 2018 ESO research dataset was used for this analysis. Of 3,480,473 adult 9-1-1 transports, 8,079 had a provider STEMI impression and were included in the analysis. Most responses (79%, n = 6,382) occurred in urban settings. In this large national dataset of patients with suspected STEMI, rural patients had longer critical prehospital-hospital time intervals compared to urban patients. Rural patients were less likely to have EMS arrival-destination transport times under 60 minutes and had longer response and total EMS times.

**56. George T.P., Chan, H.K., Crowe, R.P., Jarvis, J., Jansen, J., Wang, H. Characteristics of Out-of-Hospital Shock in a National Cohort of Emergency Medical Services Agencies. The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA**

The study objective was to describe the clinical characteristics and course of shock care in a national cohort of EMS agencies. The 2018 ESO research dataset was used for this analysis. Among 6,156,895 adult 9-1-1 responses from 1,289 EMS agencies, shock was present in 62,876 (1.02%; 95%CI:1.01-1.03), including 54,239 (86.3%) medical and 5,978 (9.5%) traumatic, and 2,650 unknown. In this national series, 1 of every 100 EMS encounters involved shock. Approximately 1 of every 10 shock patients did not improve with EMS care.

**57. Jarvis J., Hamilton V., Taigman M., Brown L. Results of Using Red Lights and Sirens for Emergency Ambulance Calls: How Often Are Potentially Life-Saving Interventions Performed? The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to identify and describe the frequency and nature of 9-1-1 calls that result in potentially life-saving interventions (pLSI) at any time during the call and within 6 minutes of EMS arrival. The 2018 ESO research dataset was used for this analysis. There were 5,393,570 calls from 1,199 agencies included in the analysis. The majority (86.1%) of calls utilized RLS, yet few (5.0%) resulted in pLSI. In this large national dataset, RLS responses were very common (86%) yet potentially lifesaving interventions were infrequent and rarely performed within 6 minutes of arrival on scene.

**58. Van Vleet, L., Burton, B., Crowe, R.P., Page, D., Wang, H. A Descriptive Assessment of EMS Encounters for Patients Experiencing Behavioral Health Emergencies. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA. and the annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to describe characteristics of EMS patients experiencing behavioral health emergencies. The 2018 ESO Health Data Exchange research database was used for this analysis. Inclusion criteria consisted of 9-1-1 responses for adult patients (older than 18 years) with a documented EMS provider primary or secondary impression of a behavioral or psychiatric etiology transported to the ED. Substance abuse and overdose were specifically excluded. A behavioral health emergency was present in 213,410 (4%) of responses. There were 21,901 (10%) excluded because the patient age less than 18. Of the remaining 191,509 encounters, there were 146,124 (76%) transports by EMS. Median age was 41 (IQR 29-56), 51% were male, 69% were white (non-Hispanic) and 25% were black (non-Hispanic). Hospital outcome data was available for 15,500 encounters (11%). Of these, 51% (7,948) were discharged home in 24 hours or less.

**59. Wampler, D., Tenley, L., Crowe, R.P., Jarvis, J., The Epidemiology of EMS-Witnessed Cardiac Arrest in a U.S. Patient Cohort. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA. and The annual meeting of the National Association of Emergency Medical Service Physicians. 2020. San Diego, CA.**

The study objective was to describe the epidemiology of EMS-witnessed cardiac arrests. The 2018 ESO research dataset was used for this analysis. Of the emergency responses for documented cardiac arrests among adult patients, EMS witnessed 8,014 (13%). Among EMS-witnessed cardiac arrest patients, median age was 65 (IQR 53-76), 71% were white (non-Hispanic), and 60% were male. Presumed etiology of EMS-witnessed arrests included cardiac (54%), followed by respiratory

(25%), trauma (12%), and drug overdose (2%). Initial arrest rhythm was shockable in 21% of witnessed arrests, while PEA or asystole was documented in 73% of cases. Common locations where EMS-witnessed cardiac arrests occurred included residences (70%), streets/highways (10%), and nursing homes/assisted living centers (8%). Circulation was restored in 43% of cases.

**60. Schroeder, R., Crowe, R.P., Myers, B., Bourn, S., Fernandez, A.R. Evaluating the Utility of Initial Prehospital Shock Index and Modified Shock Index to Predict Hospital Sepsis and Septic Shock Diagnosis. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to evaluate prehospital initial shock index and modified shock index as predictors of hospital sepsis diagnosis. The 2018 ESO Health Data Exchange research database was used for this analysis. All medical 9-1-1 responses with linked hospital diagnoses were included. Patients under 18 and those with traumatic injuries were excluded. Sepsis/septic shock diagnosis was defined using hospital ICD10 codes. Shock Index was calculated by dividing initial heart rate by SBP. Modified Shock Index was calculated by dividing initial heart rate by mean arterial pressure. Elevated Shock Index was defined as >1.0 and elevated Modified Shock Index was >1.3. Multivariable logistic regression models were used to evaluate Shock Index and Modified Shock Index as predictors of sepsis/septic shock, controlling for patient age, gender, race/ethnicity, community size, and geographic region. Over a five-fold increase in odds of sepsis diagnosis was observed for patients with an elevated initial SI (aOR:5.30, 95%CI:5.08-5.52) or MSI (aOR:5.42, 95%CI:5.21-5.64). A nine-fold increase in odds of septic shock was observed for patients with an elevated SI (aOR:9.05, 95%CI:8.32-9.85) or MSI (aOR:8.61, 95%CI:7.92-9.36). Elevated Shock Index and Modified Shock Index were strongly associated with hospital sepsis diagnosis among this group of all EMS encounters for patients with a presumed medical etiology.

**61. Alier, A., Kaye, S.P., Wilson, J.K., Wronski, R.A., Fernandez, A.R. Evaluating the Current EMS Workforce in South Carolina. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to describe the current EMS workforce in South Carolina with respect to patient contacts, number of agency rosters on which they appear, roles, and years of experience. ESO state repository data was used for this analysis. This cross-sectional evaluation included all certified South Carolina EMS professionals in 2019. There were 11,197 South Carolina EMS certified individuals in 2019. Of those, 3,138 (27.9%) were not listed on any agency rosters. There were 8,069 (72.1%) who appeared on at least 1 agency roster. Number of rosters ranged from 1 to 20 with a median of 1 (interquartile range [IQR]: 1-2). There were 1,757 (21.8%) individuals who appeared on a roster but, had no patient contact within the last 12 months. There were 7,823 field providers. Experience ranged from <1 to 47.1 years with a median of 5.2 (IQR: 2.4-11.3). There were 545 in management/operations. Experience ranged from <1 to 47 years with a median of 14.1 (IQR: 6.3-24.6). There were 360 in leadership/administration. Experience ranged from <1 to 47 with a median of 17.0 (IQR: 7.3-26.5). There were 29 educators. Experience ranged from 3.7 to 46.8 years with a median of 16.0 (IQR: 8.9-27.2).

**62. Renkiewicz, G.K., VanVleet, L., Baggett, B., Elmore, A., Ross, M., Martin, M. Disparate Treatment of the Pediatric Diabetic Patient in the Prehospital Setting. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to identify disparities in the prehospital treatment of pediatric diabetic emergencies. The 2017 ESO research dataset was used for this analysis. Inclusionary criteria consisted of patients whose lowest blood glucose level was less than 70 mg/dL, had a total

Glasgow Coma Score of 14 or less, and had a primary impression that suggested a potential blood glucose level abnormality. A primary impression of altered level of consciousness was statistically significant (OR 8.05,  $p=0.029$ ) regarding the treatment of prehospital pediatric hypoglycemia. The study identified no discernable disparity in the treatment of prehospital pediatric diabetic patients filtered by age in years, weight, gender, or minority status.

**63. Renkiewicz, G.K., Dean, B., Houston, S., Taylor, S., Howell, S., Cornelius, C. Pediatric Cardiac Arrest Resuscitation by EMS (CARE). The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to examine factors influencing the likelihood of achieving field return of spontaneous circulation in pediatric out-of-hospital cardiac arrest. The 2017 ESO research dataset was used for this analysis. Compared to unwitnessed arrests, patients were more likely to achieve return of spontaneous circulation when arrests were witnessed by a healthcare provider (OR 6.53,  $p=0.003$ ), bystander (OR 2.94,  $p=0.001$ ), or family member (OR 2.77,  $p=0.016$ ). Field return of spontaneous circulation was also associated with Caucasian race (OR 2.39,  $p=0.004$ ), use of CPR feedback device (OR 2.21,  $p=0.007$ ), and quicker epinephrine administration (OR 0.98,  $p=0.042$  per minute from 9-1-1 call received time to first epinephrine administration). The child age group (2-18 years) also exhibited improved odds of ROSC (OR 2.11,  $p=0.008$ ).

**64. Burchette, E., Hubble, M.W., Renkiewicz, G.K., Stallings, D., Tripp, H. Impact of Delayed Epinephrine Administration on Return of Spontaneous Circulation During Pediatric Out-of-Hospital Cardiac Arrest. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to evaluate the effect of vasopressor administration delay on field return of spontaneous circulation in pediatric out-of-hospital cardiac arrest. The 2017 ESO research dataset was used for this analysis. Patients receiving advanced airway control prior to epinephrine administration had longer scene-arrival-to-pressor intervals (24.9 vs. 19.3 minutes,  $p<0.01$ ). Significant adjusted odds ratios for return of spontaneous circulation included call-receipt-to-pressor interval (per minute; OR 0.97,  $p<0.01$ ); patient age (per year; OR 1.06,  $p<0.01$ ); non-Caucasian race (OR 0.43,  $p=0.01$ ); and witnessed arrests (OR 2.88,  $p<0.01$ ). In addition, compared to arrests of cardiac etiology, arrests of respiratory (OR 2.42,  $p=0.01$ ) and other etiologies (OR 2.12,  $p=0.04$ ) were more likely to attain return of spontaneous circulation. An increased likelihood of return of spontaneous circulation was associated with an initial ECG of VF/VT or shockable AED rhythm (OR 3.06,  $p<0.01$ ), PEA (OR 5.97,  $p<0.01$ ), and unknown AED nonshockable rhythm (OR 8.42,  $p=0.03$ ) when compared to asystole.

**65. Van Vleet, L., Baggett, B., Elmore, A., Ross, M., Martin, M. Likelihood of Bystander CPR in Pediatric Cardiac Arrest. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to determine the incidence of layperson CPR in witnessed pediatric cardiac arrest and demographic factors that may impact the likelihood of layperson efforts. The 2017 ESO research dataset was used for this analysis. Among the 269 pediatric patients included in the study, 54.8% received layperson CPR. Gender was the only factor that showed a statistically significant ( $p=0.048$ ) difference in the odds of bystanders to perform CPR, with females 2.05 times greater odds than males to receive layperson CPR. There was no difference in age, weight, race, and cardiac arrest etiology regarding performance of layperson CPR.

**66. Renkiewicz, G.K., Tripp, H.E., Burchette, E., Stallings, D. A., Hubble, M.W. An Epidemiology of Pediatric Suicide Attempts. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to describe epidemiological and patient-related factors of a nationwide population of prehospital pediatric suicide attempts. The 2017 ESO research dataset was used for this analysis. Mean age was  $15.5 \pm .05$  years with a range of 6-18. Patients identified as prepubescent (<13 years) accounted for 15.3% (n=413) of the sample. Average EMS response time was  $11.75 \pm 33.36$  minutes, and 457 (16.9%) attempts had a traumatic component. Suicidal ideations without actual attempt were the highest subgrouping (n=990; 36.7%), followed by nonspecific suicide attempt (n=414; 15.3%), overdose (n=390; 14.5%), lacerations (n=172; 6.4%), and depressive symptoms (n=101; 3.75%). Upon EMS arrival, 5 patients were observed to be in cardiac arrest. Of these, resuscitation was attempted on 2, and 1 achieved return of spontaneous circulation. Twelve patients were intubated.

**67. Renkiewicz, G.K., Watkins, A., Collopy, K., Hoover, J., Tuttle, J. Impact of Pediatric Age Groups on Prehospital Intubation Success. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to evaluate whether prehospital overall endotracheal intubation success varied based on patient age. The 2017 ESO research dataset was used for this analysis. Adolescents were the most commonly intubated age group (n=164; 29.66%), followed by infants (n=160; 28.93%), toddlers (n=82; 14.82%), school-aged children (n=60; 10.84%), preschoolers (n=45; 8.13%), and neonates (n=42; 7.59%). Compared to adolescents, neonates (OR 0.404; p=0.014) and those patients not receiving paralytics were less likely to obtain overall endotracheal intubation success (OR 0.404; p=0.049). Neither sex nor minority status were statistically significant predictors of ETI success.

**68. Van Vleet, L., Baggett, B., Elmore, A., Ross, M., McNeil, M. Treatment Equity Among Pediatric Diabetic Patients in the Prehospital Setting. The Prehospital Care Research Forum International Scientific Symposium at EMS Expo. 2019. New Orleans, LA.**

The study objective was to identify disparity in prehospital treatment of pediatric diabetic emergencies. The 2017 ESO research dataset was used for this analysis. Inclusion criteria consisted of patients whose lowest blood glucose level was less than 70 mg/dL and had a total Glasgow coma score of 14 or less and a primary impression that may have been related to blood glucose level abnormalities. total of 36.7% (92) patients received an included treatment modality, and 63.3% (159) patients were not treated. This study identified no discernable disparity in treatment of prehospital pediatric diabetic patients when examined by age in years, weight, gender, or minority status.

**69. Mills, M., Crowe, R.P., Myers, B., Wilson, J.K., Kaye, S.P., Fernandez, A.R. An Assessment of the Relationship between the Total Prehospital Naloxone Dose Administered and EMS Transport in West Virginia. The 2019 National Association of State EMS Officials Annual Meeting. 2019. Salt Lake City, UT. Awarded 1st Place Research Abstract.**

The study objective was to assess the relationship between the total dose of prehospital naloxone administered and EMS transport of suspected opioid patients to an emergency department in West Virginia. ESO state repository data was used for this analysis. All 9-1-1 calls where one or more doses of prehospital naloxone were administered in West Virginia from January 1, 2016 to December 31, 2017 were assessed. There were 613,011 total 9-1-1 call and 1.5% where the patient received prehospital naloxone in West Virginia during the study period. Of those, 82.2% were

transported and 17.8% were not transported. The assessment of the relationship between total prehospital dose of naloxone and patient transport in West Virginia did not reveal a significant relationship. The average total dose for those who were not transported was 1.6 milligrams (standard deviation 0.7) with a median of 2 (interquartile range 1-2).

**70. Wilson, J.K., Crowe, R.P., Myers, B., Ezzell, Zalkin, J., Nelson, R.D., Winslow, J., Fernandez, A.R. North Carolina EMS Providers' Experiences and Attitudes Regarding Workplace Violence and Safety. The 2019 National Association of State EMS Officials Annual Meeting. 2019. Salt Lake City, UT.**

The study objective was to assess the proportion of EMS providers in North Carolina who reported one or more forms of assault while on duty in the past 24 months and to identify demographic and work-related factors associated with the report of being assaulted. Secondly, EMS providers' attitudes regarding workplace safety and management of workplace assaults events were examined. All responses obtained from an online survey distributed via multiple listservs for EMS providers in North Carolina in June and July of 2018 were assessed. Over two-thirds of respondents indicated that they had been physically or verbally assaulted in the workplace in the last 24 months. Those who reported an assault in the last 24 months felt less safe at work and less able to manage physical violence. There was an increase in perceived ability to manage violence by those who had not experienced violence potentially indicating that providers are overconfident or unaware of potential threats.

**71. Alier, A., Kaye, S.P., Crowe, R.P., Myers, B., Wronski, R.A., Wilson, J.K., Fernandez, A.R. An Assessment of EMS Longevity and the Current EMS Workforce in South Carolina. The 2019 National Association of State EMS Officials Annual Meeting. 2019. Salt Lake City, UT.**

The study objective was to describe the length of time EMS providers in South Carolina remain in the workforce and identify factors related to longevity. ESO state repository data was used for this analysis. All EMS providers who held an EMS certification in South Carolina from 1970 to 2019 were assessed. Those currently certified in South Carolina have similar years of EMS experience and are similar in age to those who are no longer certified. Currently certified individuals may be on the verge of leaving the field. Moreover, this study revealed that almost three-quarters of the South Carolina EMS workforce maintained their EMS certification for less than 8 years, over 90% don't make it to 20 years of service and over 98% do not accumulate enough service time to retire from EMS. Females maintain EMS certification for fewer years compared to males and EMTs maintain certification for fewer years compared to paramedics.

**72. Humlen-Ahearn, P., Hadland L., Crowe R.P., Brown L., Using Prehospital Screening Tools to Identify Large-Vessel Occlusion, in National Association of EMS Physicians. ESO Wave 2019. 2019: Austin, TX.**

The study objective was to determine the test characteristics for commonly used prehospital stroke scales for detecting large-vessel occlusion. The 2017 ESO research database was used for this analysis. The study included all patients with both a stroke screening and health data exchange hospital outcome data. large-vessel occlusion was identified using ICD-10 diagnosis. There were 1,712 patients with both stroke screening and HDE outcome data, 3% had documented large-vessel occlusion. Only 14% of the patients were assessed using RACE/LAMS. The sensitivity of RACE/LAMS was 100% (CI: 60%-100%) and the negative predictive value was 100% (CI: 97%-100%), but the specificity (53%, CI: 46%-59%) and positive predictive value (6%, CI: 2%-12%) were poor. Use of the LAMS/RACE > 4 stroke-screening tools or two or more screening characteristics by EMS is a poor predictor of large-vessel cerebral occlusions.

**73. Jarvis, J., Biasatti M., Gonzales J., Johns D. Esmolol Use for Refractory Ventricular Fibrillation: A Prehospital Case Series, in National Association of EMS Physicians. ESO Wave 2019. 2019: Austin, TX.**

The study objective was to describe the characteristics of patients in refractory VF treated with esmolol. ESO data from a single suburban EMS system was used for this analysis. Between October 2017 and June 2018, thirteen patients received esmolol 500 mcg/kg bolus followed by an infusion. There was no significant difference between the esmolol and non-esmolol groups on any variable evaluated in this study. The use of esmolol did not improve outcomes but it did decrease the proportion of patients transported with CPR in progress.

**74. Waddell, M. Focused Stroke Education in Emergency Medical Services (EMS). 2019. ESO Wave 2019. Austin, TX.**

The study objective was to determine if there was a significant difference in the number of stroke patients that bypassed local primary stroke centers prior to and after attending Advanced Stroke Life Support education. ESO data from a single county-based EMS system was used for this analysis. Three years of EMS clinical data prior to Advanced Stroke Life Support education was compared to three years of clinical data following Advanced Stroke Life Support education. Results from this study indicated that Advanced Stroke Life Support training did not reduce the likelihood of EMS providers by-passing local primary stroke centers.

**75. Ashburn, N., Ryder C.W., Angi R.M., Snaveley A.C., Nelson R.D., Bozeman W.P., McGinnis H.D., Winslow J.E., Stopyra J.P. One-Year Mortality After Receiving Prehospital Naloxone for Suspected Opioid Overdose, in Society for Academic Emergency Medicine. 2019: Las Vegas NV.**

The objective of this study was to determine the one-year mortality rate of patients who receive prehospital naloxone from emergency medical services. ESO data from seven North Carolina county EMS agencies was queried for naloxone administration over a twenty-six-month period (1/2015-2/2017). There were 3,099 naloxone administrations. Nearly 15% of patients died within one-year of receiving prehospital naloxone.

**76. Arkins, T., Sigle R., Page D., Crowe R.P. Barton D, Can 911 Dispatchers Reliably Identify Patients Suffering a Stroke?, in National Association of EMS Physicians 2019: Austin, TX.**

The study objective was to evaluate the ability of a 911 dispatcher to reliably identify a patient who is suffering a stroke or transient ischemic attack. The 2017 ESO research database was used for this analysis. Only run types listed as 911 responses with health data exchange hospital outcomes of stroke or TIA were included. A total of 2,199 cases were identified for inclusion and analysis. Dispatchers were able to correctly identify a stroke patient 39% of the time. Dispatchers are not able to reliably identify a patient suffering a stroke or TIA.

**77. Burton, B., Van Vleet L., Crowe R.P., Page D., Barton D., Wang H., Disparities in Prehospital Analgesia for Trauma Patients in the United States, in Prehospital Care Research Forum EMS World Expo & National Association of EMS Physicians. ESO Wave 2019. 2018/2019: Nashville and Austin.**

The study objective was to characterize differences by age, sex, race, and region in EMS analgesia administration to injured patients. The 2017 ESO research database was used for this analysis. There were 118,203 injured patients with pain score  $\geq 7$  and 9% received analgesia. EMS analgesia administration differs by age, sex, race and region. Average age among this injured patient population was 50 years and 43% were male. Compared with young adults (age 18-29 years), children were less likely to receive analgesia (OR: 0.57, 95% CI: 0.45-0.70). Older patients ( $\geq 70$

years) were more likely to receive analgesia (OR: 1.18, 95% CI: 1.10-1.26). Males were more likely to receive analgesia (OR: 1.23, 95% CI: 1.19-1.29) Patients identified as Black or African American were less likely than White, non-Hispanic patients to receive analgesia (OR: 0.60, 95% CI: 0.56-0.63).

**78. Jarvis, J., Phillips D., Crowe R.P. Response, Agency, and Patient Characteristics Associated with EMS Transport Rates, in Prehospital Care Research Forum EMS World Expo & National Association of EMS Physicians. 2018/2019: Nashville & Austin.**

The study objective was to identify response, agency and patient characteristics associated with EMS transport rates. The 2017 ESO research database was used for this analysis. There were 2,786,615 electronic health records; 85% resulted in EMS transport by over 900 agencies. Compared to third service agencies, private agencies demonstrated 80% greater odds of transporting (aOR:1.80, 95%CI:1.78-1.84). Compared to non-volunteer agencies, volunteer agencies demonstrated 31% increased odds of transport (aOR:1.31, 95%CI:1.26-1.36). Hispanic patients demonstrated 26% decreased odds of transport compared to non-Hispanic White patients (aOR:0.74, 95%CI:0.73-0.75). Compared to patients aged 18-39, patients in older patients had progressively greater odds of transport with each age group, the largest aOR being 2.62 (95%CI:2.59-2.65) for those over 79. Patients younger than 18 years had lower odds of transport (aOR:0.74, 95%CI:0.73-0.75).

**79. Kordik, S., Smith C., Page D., Crowe R.P., Myers B., Wampler D. Increased Frequency of Adverse Events Observed after Ketamine Use for Psychiatric Emergency as Compared to Benzodiazepines and Antipsychotics, in Prehospital Care Research Forum EMS World Expo & National Association of EMS Physicians. 2018/2019: Nashville & Austin.**

The study objective was to evaluate adverse events after administration of ketamine compared to benzodiazepines or antipsychotics in the prehospital treatment of psychiatric patients. The 2017 ESO research database was used for this study. The analysis included patients over 13 years experiencing a psychiatric emergency and receiving a single dose of ketamine, benzodiazepine, or antipsychotic. There were 3,020 patients included, 11% received ketamine, 71% received a benzodiazepine, and 17% received an antipsychotic. The adverse event rate for all psychiatric patients administered sedation was  $\leq 11\%$ . For psychiatric patients requiring treatment, those who received ketamine received significantly more airway management than patients who received a benzodiazepine or antipsychotic.

**80. Jarvis, J., Wampler D., Wang H. First Pass Airway Success Rates Out-of-Hospital Advanced Airway Management in Adults and Children, in Prehospital Care Research Forum EMS World Expo & National Association of EMS Physicians. ESO Wave 2019. 2018/2019: Nashville & Austin.**

The study objective was to compare advanced airway management first-pass success rates between adults and children. The 2017 ESO research database was used for this analysis. All patients receiving any advanced airway management attempts were included. Advanced airway management was attempted on 29,369 patients including 28,846 (98.2%) adults and 523 (1.8%) children. endotracheal intubation first pass success was lower in children than adults (58.6% vs 72.7%). Supraglottic airway first pass success does not differ between children and adults (84.6% vs 89.8%).

**81. Jarvis, J., Curtis L., Prehospital Use of Ketamine, Morphine or Fentanyl for the Management of Acute Pain Following Traumatic Injury, in Prehospital Care Research Forum, EMS World Expo & National Association of EMS Physicians. ESO Wave 2019. 2018/2019: Nashville & Austin.**

The study objective was to compare the analgesic effects of low-dose ketamine, fentanyl, and morphine for the treatment of acute, traumatic pain in the prehospital environment. The

2017 ESO research database was used for this analysis. All patients >12 years old with an initial pain score of  $\geq 5$  and at least one subsequent pain score documented who were treated with ketamine, fentanyl, or morphine following traumatic injury were included. There were 35,906 analyzed, 80.0% received fentanyl, 18.2% received morphine, and 1.8% received ketamine. There was no significant difference in pain reduction when the ketamine group (84.8%) was compared to either the fentanyl group (85.8%) or the morphine group (83.6%), but fentanyl was associated with significant reduction in pain compared to morphine.

**82. Jarvis, J., Phillips D., Crowe R.P. Characteristics of EMS Transport Refusal Following Glucose or Naloxone Administration, in Prehospital Care Research Forum EMS World Expo & National Association of EMS Physicians. ESO Wave 2019. 2018/2019: Nashville and Austin.**

The study objective was to describe the characteristics of transport refusal among patients who received glucose, naloxone, or neither medication. The 2017 ESO research database was used for this analysis. The analysis included 2,778,921 electronic health records. Transport refusal rates were higher for those given glucose and lower for those given naloxone compared with those given neither. Overall, 14% of all responses resulted in transport refusal with 7% of those given naloxone, 39% given glucose, and 14% given neither drug refusing transport.

**83. Jarvis, J., Barton D., Sager L., Nudell N. Benchmarking EMS Compass Stroke Performance Measures Using a Large National Dataset, in National Association of EMS Physicians. 2018: San Diego, CA.**

The study objective was to describe national stroke performance measure benchmarks including prehospital use of stroke screening tools and assessment of blood glucose levels among EMS stroke patients. Six and a half years of ESO data were analyzed. There were 168,854 patients who had a impression of acute stroke and were transported from the scene of a 9-1-1 call included in the analysis. Of those, 52.6% had a documented stroke scale and 83.1% had a documented glucose level. This was the first study to calculate national benchmarks for stroke related EMS Compass measures.

**84. Jarvis, J., Barton D., Sager L., Nudell N. Benchmarking EMS Compass Performance Measures using a Large National Dataset: Pediatric Care, in National Association of EMS Physicians. 2018: San Diego, CA.**

The study objective was to describe national pediatric performance measures benchmarks including documentation of weights, SpO<sub>2</sub>, Respiratory Rate, for those with any respiratory illness as well as at least one dose of beta-agonist given for those with asthma and an SpO<sub>2</sub> 90%. Six and a half years of ESO data were analyzed. There were 524,856 9-1-1 patients under 15 years of age included in the analysis with 54.8% having a documented weight. There were 43,067 children with a respiratory impression and 87.5% of these had at least one documented SpO<sub>2</sub> and Respiratory Rate. Of the 755 children with an impression of asthma and SpO<sub>2</sub> <90%, 84.1% received a beta-agonist. This was the first study to calculate national benchmarks for pediatric related EMS Compass measures.

**85. Jarvis, J., Barton D., Sager L., Nudell N. Benchmarking EMS Compass Cardiac Performance Measures using a Large National Dataset, in National Association of EMS Physicians. 2018: San Diego, CA.**

The study objective was to describe national benchmarks for national cardiac performance measures including the time from dispatch to first defibrillation in shockable rhythms, the proportion of these provided within 5 minutes, the proportion of patients over 35 with non-traumatic chest pain who received both aspirin and a 12 lead ECG, and the proportion of patients

with acute decompensated heart failure (as defined by SBP > 200 and either a RR > 30 or an SpO<sub>2</sub> < 90) who received both nitroglycerin and non-invasive pressure ventilation. Six and a half years of ESO data were analyzed. There were 11,144 cardiac arrests with an initial shockable rhythm, 14.6% were defibrillated within 5 minutes and the average time to first shock was 13.65 minutes. There were 533,127 patients over 35 with non-traumatic chest pain, 37.4% received both aspirin and a 12 lead ECG. There were 2,612 patients with acute decompensated heart failure and 80.4% received both nitroglycerin and non-invasive pressure ventilation. This was the first study to calculate national benchmarks for cardiac related EMS Compass measures.

**86. Jarvis, J., Barton D., Sager L., Nudell N. Benchmarking the Use of Red Lights and Sirens in 9-1-1 Systems: A Review of a Large National Dataset, in National Association of EMS Physicians. 2018: San Diego, CA.**

The study objective was to describe national benchmarks for red lights and sirens utilization performance measures. Six and a half years of ESO data were analyzed. There were 7,709,012 9-1-1 calls that resulted in patient transport. 75.8% utilized red lights and sirens to the scene and 19.4% utilized red lights and sirens from the scene to the hospital. This was the first study to calculate national benchmarks for red lights and sirens use related EMS Compass measures.

**87. Jarvis, J., Barton D., Sager L., Nudell N. EMS Compass Benchmarks using a National EMS Dataset: Status Epilepticus and Hypoglycemia Performance Measures, in National Association of EMS Physicians. 2018: San Diego, CA.**

The study objective was to describe national benchmarks for status epilepticus and hypoglycemia performance measures. Six and a half years of ESO data were analyzed. There were 147,238 patients with documented blood glucose <60, 79.7% received glucose. There were 11,148 patients with status epilepticus, 72.4% had a documented blood glucose and 56.1% had a benzodiazepine administered. This was the first study to calculate national benchmarks for status epilepticus and hypoglycemia related EMS Compass measures.

**88. Jarvis, J., Barton D., Sager L., Nudell N. Benchmarking EMS Compass Trauma Scene Times and Traumatic Pain Management Performance Measures using a National Dataset, in National Association of EMS Physicians. 2018: San Diego, CA.**

The study objective was to describe national benchmarks for trauma scene times and traumatic pain management performance measures. Six and a half years of ESO data were analyzed to calculate benchmarks for: (1) the percentage of patients with trauma alert criteria as defined by the CDC trauma triage criteria for transport to a trauma center who have a scene time under 10 minutes, and (2) of patients with any traumatic injury, the proportion with at least one pain scale documented. For those with an initial pain score >5, the proportion with a second score reassessing pain. Of patients from ALS agencies who had an initial score >5, the proportion with decreased pain from the first to last pain score. There were 66,414 critical trauma patients and 24.3% had a scene time less than 10 minutes. The average scene time was 16.4 minutes. There were 2,166,680 trauma patients, 48.6% had a documented pain score. Of the 503,656 patients with an initial pain score of >5, 20.6% experienced improvements in pain scores. This was the first study to calculate national benchmarks for trauma scene times and traumatic pain management related EMS Compass measures.

**89. Jarvis, J., Wang, HE., Barton, D. Cumulative Success of Prehospital Advanced Airway Management in a National Cohort, in Prehospital Care Research Forum/EMS World & National Association of EMS Physicians. ESO Wave 2018. 2017/2018: Las Vegas & San Diego. Austin.**

The study objective was to characterize cumulative Advanced Airway Management success rates in a national cohort of EMS agencies. Nine years of ESO data were analyzed. There were 61,793 patients that had Advanced Airway Management attempted included in the analysis. Results indicated that first pass prehospital Advanced Airway Management success rates improved from prior studies but were still low. Multiple attempts were common and often unsuccessful.