Introduction. Prehospital personnel frequently encounter agitated, combative, and intoxicated patients in the field. In recent years, ketamine has been described as an effective sedative agent to treat such patients; however, a paucity of research exists describing the use of prehospital ketamine. The objective of this study was to provide a descriptive analysis of the Columbus Division of Fire’s experience with utilizing ketamine in the prehospital setting. We hypothesized that ketamine administration improves patient condition, is effective at sedating patients, and does not result in endotracheal intubation in the prehospital setting or in the emergency department (ED).

Methods. We conducted a retrospective cohort chart review of Columbus Division of Fire patient care reports and hospital records from destination hospitals in the central Ohio region between October 2010 and October 2012. All patients receiving ketamine administered by Columbus Division of Fire personnel for sedation were included. Patients 17 years and younger were excluded. The primary outcome was the percentage of patients noted to have an “improved” condition recorded in the data field of the patient care report. The secondary outcomes were the effectiveness of sedation and the performance of endotracheal intubation.

Results. A total of 36 patients met inclusion criteria over the study period. Data were available on 35 patients for analysis. The mean IV dose of ketamine was 138 mg (SD = 59.5, 100–200). The mean IM dose of ketamine was 324 mg (SD = 120, 100–500). Prehospital records noted an improvement in patient condition after ketamine administration in 32 cases (91%, 95% CI 77–98%). Six patients required sedation post-ketamine administration either by EMS (2) or in the ED (4) (17%, 95% CI 6.5–34%). Endotracheal intubation was performed in eight (23%, 95% CI 10–40%) patients post-ketamine administration.

Conclusion. We found that in a cohort of patients administered ketamine, paramedics reported a subjective improvement in patient condition. Endotracheal intubation was performed in 8 patients. Key words: prehospital; agitation; ketamine

PREHOSPITAL EMERGENCY CARE 2015;19:110–115
Purpose. To investigate the effect of ice slurry ingestion precooling on body core temperature ($T_c$) during exertion in wildland firefighting garments in uncompensable heat stress. **Methods.** On two separate trials, 10 males ingested 7.5 g·kg$^{-1}$ of either an ice slurry (0.1°C) or control beverage (20°C) during seated rest for 30 minutes prior to simulating the U.S. Forest Service Pack Test on a treadmill in wildland firefighting garments in a hot environment (38.8 ± 1.2°C, 17.5 ± 1.4% relative humidity). Deep gastric temperature, mean skin temperature ($T_{sk}$), and heart rate (HR) were recorded. Ratings of perceived exertion, thermal sensation, comfort, and sweating were assessed. **Results.** Compared with ingestion of a temperate beverage, precooling with ice slurry before exertion in a hot environment reduced $T_c$ during the first 30 minutes of the exercise bout. Exercise time and distance completed were not different between treatments. Skin temperature, heart rate, and perceptual responses rose in both conditions during exercise but did not differ by condition. **Conclusion.** Pretreatment with ice slurry prior to exertion in wildland firefighting garments results in a modest reduction in $T_c$ during the first 30 minutes of exercise when compared to pretreatment with control beverage but the ice slurry precooling advantage did not persist throughout the 45-minute exercise protocol. **Key words:** drink temperature; thermoregulation; preexercise cooling; firefighter

THE EFFECTS OF ICE SLURRY INGESTION BEFORE EXERTION IN WILDLAND FIREFIGHTING GEAR

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Introduction. Diazepam and midazolam are commonly used by paramedics to treat seizures. A period of drug scarcity was used as an opportunity to compare their effectiveness in treating prehospital seizures. Methods. A retrospective chart review of a single, large, commercial agency during a 29-month period was performed. The period included alternating shortages of both medications. Ambulances were stocked with either diazepam or midazolam based on availability of the drugs. Adult patients who received at least 1 parenteral dose of diazepam or midazolam for treatment of seizures were included. The regional prehospital protocol recommended 5 mg intravenous (IV) diazepam, 5 mg intramuscular (IM) diazepam, 5 mg IM midazolam, or 2.5 mg IV midazolam. Medication effectiveness was compared with respect to the primary end point: cessation of seizure without repeat seizure during the prehospital encounter. Results. A total of 440 study subjects received 577 administrations of diazepam or midazolam and met the study criteria. The subjects were 52% male, with a mean age of 48 (range 18–94) years. A total of 237 subjects received 329 doses of diazepam, 64 (27%) were treated with first-dose IM. A total of 203 subjects received 248 doses of midazolam; 71 (35%) were treated with first-dose IM. Seizure stopped and did not recur in 49% of subjects after parenteral diazepam and 65% of subjects after parenteral midazolam ($p = 0.002$). Diazepam and midazolam exhibited similar first-dose success for IV administration (58 vs. 62%; $p = 0.294$). Age, gender, seizure history, hypoglycemia, the presence of trauma, time to first administration, prehospital contact time, and frequency of IM administration were similar between groups. Conclusion. For parenteral administration, midazolam demonstrated superior first-dose seizure suppression. This study demonstrates how periods of drug scarcity can be utilized to study prehospital medication effectiveness. Key words: Emergency medical services; seizures; midazolam; diazepam; anticonvulsants

**Parenteral Midazolam Is Superior to Diazepam for Treatment of Prehospital Seizures**

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PREHOSPITAL EMERGENCY CARE 2015;19:218–223
Background. Prehospital identification of STEMI and activation of the catheterization lab can improve door-to-balloon (D2B) times but may lead to decreased specificity and unnecessary resource utilization. The purpose of this study was to examine the effect of electrocardiogram (ECG) transmission on false-positive (FP) cath lab activations and time to reperfusion. Methods. This is a retrospective cohort from a registry in a large metropolitan area with regionalized cardiac care and emergency medical services (EMS) with ECG transmission capabilities. Thirty-four designated STEMI receiving centers (SRC) contribute to this registry, from which patients with a prehospital ECG software interpretation of myocardial infarction (MI) indicated by ****Acute MI****, or manufacturer equivalent, were identified between April 2011 and September 2013. Frequency of FP field activations (defined as not resulting in emergent percutaneous coronary intervention [PCI] or referral for CABG during hospital admission) for patients with ECG transmission received by the SRC was compared to a reference group without successful ECG transmission. FP field activations were compared to the baseline frequency of FP ED activations. We hypothesized that successful transmission would reduce FP field activation to ED activation levels. Door-to-balloon and first medical contact-to-balloon (FMC2B) times were compared. The protocol for field cath lab activation varied by institution. Results. There were 7,768 patients presenting with a prehospital ECG indicating MI. The ECG was received by the SRC for 2,156 patients (28%). Regardless of transmission, the cath lab was activated 77% of the time; this activation occurred from the field in 73% and 74% of the activations in the transmission and reference group, respectively. The overall proportion of FP activation was 57%. Among field activations, successful ECG transmission reduced the FP activation rate compared to without ECG transmission, 55% vs. 61% (RD = -6%, 95% CI -9, -3%). This led to an overall system reduction in FP activations of 5% (95% CI 2, 8%). ECG transmission had no effect on D2B and FMC2B time. Conclusion. Prehospital ECG transmission is associated with a small reduction in false-positive field activations for STEMI and had no effect on time to reperfusion in this cohort. Key words: emergency medical services; myocardial infarction; myocardial reperfusion; electrocardiography

The Utility of Prehospital ECG Transmission in a Large EMS System
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Prehospital Emergency Care 2015;19:496–503
Introduction. Infection is a major cause of morbidity and mortality in trauma. Infection in trauma is poorly understood. The impact of prehospital invasive airway management (IAM) on the incidence of pneumonia and health services utilization is unknown. We hypothesized that trauma patients exposed to prehospital IAM will suffer higher rates of pneumonia compared to no IAM or exposure to IAM performed in the hospital. We hypothesized that patients who develop pneumonia subsequent to prehospital IAM will have longer intensive care unit (ICU) and hospital length of stay (LOS) compared to patients who acquired pneumonia after IAM performed in the hospital. Methods. This is an observational cohort study of data previously collected for the Resuscitation Outcomes Consortium hypertonic resuscitation randomized trial. Patients were included if traumatic injury resulted in shock, traumatic brain injury, or both. Patients were excluded if they died 24 hours after injury, or pneumonia data were missing. Adjusted and unadjusted logistic regression was used to calculate the odds ratio of pneumonia if exposed in the prehospital setting compared to no exposure or exposure in the hospital. Results. Of 2,222 patients enrolled in the hypertonic resuscitation trial, 1,676 patients met enrollment criteria for this study. Four and a half percent of patients suffered pneumonia. IAM in the prehospital setting resulted in 6.8-fold increase (C.I. 2.0, 23.0, p = 0.003) in the adjusted odds of developing pneumonia compared to not being intubated, while in-hospital intubation resulted in 4.8-fold increase (C.I. 1.4, 16.6, p = 0.01), which was not statistically significantly different to the odds ratio of prehospital IAM. There were no statistically significant increases in health services utilization resulting from pneumonia incurred after IAM. Conclusion. Exposure to IAM in prehospital and hospital settings results in an increase in pneumonia, but there does not appear to be a link between the source of pneumonia and an increase in ICU or hospital LOS. Keywords: emergency medical services; endotracheal intubation; pneumonia; infection; health services utilization

A COMPARISON OF INVASIVE AIRWAY MANAGEMENT AND RATES OF PNEUMONIA IN PREHOSPITAL AND HOSPITAL SETTINGS

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PREHOSPITAL EMERGENCY CARE 2015;19:475–481
A quality improvement initiative to optimize use of a mechanical chest compression device within a high-performance CPR approach to out-of-hospital cardiac arrest resuscitation

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\textit{Background:} Minimizing the chest compression pause associated with application of a mechanical CPR device is a key component of optimal integration into the overall resuscitation process. As part of a multi-agency implementation project, Anchorage Fire Department deployed LUCAS CPR devices on BLS and ALS fire apparatus for initiation early in resuscitation efforts. A 2012 report identified the pause interval for device application as a key opportunity for quality improvement (QI). In early 2013 we began a QI initiative to reduce device application time interval and optimize the overall CPR process. To assess QI initiative effectiveness, we compared key CPR process metrics from before to during and after its implementation.

\textit{Methods:} We included all cases of EMS-treated out-of-hospital cardiac arrest during 2012 and 2013 in which a mechanical CPR device was used and the defibrillator electronic record was available. Continuous ECG and impedance data were analyzed to measure chest compression fraction, duration of the pause from last manual to first mechanical compression, and duration of the longest overall pause in the resuscitation effort.

\textit{Results:} Compared to cases from 2012 (\(n = 61\)), median duration of the pause prior to first mechanical compression for cases from 2013 (\(n = 71\)) decreased from 21 (15, 31) to 7 (4, 12) s (\(p < 0.001\)), while median chest compression fraction increased from 0.90 (0.88, 0.93) to 0.95 (0.93, 0.96) (\(p < 0.001\)). Median duration of the longest pause decreased from 25 (20, 35) to 13 (10, 20) s (\(p < 0.001\)), while the proportion of cases where the longest pause was for mechanical CPR application decreased from 74% to 31% (\(p < 0.001\)).

\textit{Conclusions:} Our QI initiative substantially reduced the duration of the pause prior to first mechanical compression. Combined with the simultaneous significant increase in compression fraction and significant decrease in duration of the longest pause, this finding strongly suggests a large improvement in mechanical CPR device application efficiency within an overall high-performance CPR process.

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Delayed Sequence Intubation: A Prospective Observational Study

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**Study objective:** We investigate a new technique for the emergency airway management of patients with altered mental status preventing adequate preoxygenation.

**Methods:** This was a prospective, observational, multicenter study of patients whose medical condition led them to impede optimal preintubation preparation because of delirium. A convenience sample of emergency department and ICU patients was enrolled. Patients received a dissociative dose of ketamine, allowing preoxygenation with high-flow nonrebreather mask or noninvasive positive pressure ventilation (NIPPV). After preoxygenation, patients were paralyzed and intubated. The primary outcome of this study was the difference in oxygen saturations after maximal attempts at preoxygenation before delayed sequence intubation compared with saturations just before intubation. Predetermined secondary outcomes and complications were also assessed.

**Results:** A total of 62 patients were enrolled: 19 patients required delayed sequence intubation to allow nonrebreather mask, 39 patients required it to allow NIPPV, and 4 patients required it for nasogastric tube placement. Saturations increased from a mean of 89.9% before delayed sequence intubation to 98.8% afterward, with an increase of 8.9% (95% confidence interval 6.4% to 10.9%). Thirty-two patients were in a predetermined group with high potential for critical desaturation (pre—delayed sequence intubation saturations ≤ 93%). All of these patients increased their saturations post—delayed sequence intubation; 29 (91%) of these patients increased their post—delayed sequence intubation saturations to greater than 93%. No complications were observed in the patients receiving delayed sequence intubation.

**Conclusion:** Delayed sequence intubation could offer an alternative to rapid sequence intubation in patients requiring emergency airway management who will not tolerate preoxygenation or peri-intubation procedures. It is essentially procedural sedation, with the procedure being preoxygenation. Delayed sequence intubation seems safe and effective for use in emergency airway management. [Ann Emerg Med. 2015;65:349-355.]

Please see page 350 for the Editor’s Capsule Summary of this article.
Outcomes After Out-of-Hospital Cardiac Arrest Treated by Basic vs Advanced Life Support

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**IMPORTANCE** Most out-of-hospital cardiac arrests receiving emergency medical services in the United States are treated by ambulance service providers trained in advanced life support (ALS), but supporting evidence for the use of ALS over basic life support (BLS) is limited.

**OBJECTIVE** To compare the effects of BLS and ALS on outcomes after out-of-hospital cardiac arrest.

**DESIGN, SETTING, AND PARTICIPANTS** Observational cohort study of a nationally representative sample of traditional Medicare beneficiaries from nonrural counties who experienced out-of-hospital cardiac arrest between January 1, 2009, and October 2, 2011, and for whom ALS or BLS ambulance services were billed to Medicare (31,252 ALS cases and 16,413 BLS cases). Propensity score methods were used to compare the effects of ALS and BLS on patient survival, neurological performance, and medical spending after cardiac arrest.

**MAIN OUTCOMES AND MEASURES** Survival to hospital discharge, to 30 days, and to 90 days; neurological performance; and incremental medical spending per additional survivor to 1 year.

**RESULTS** Survival to hospital discharge was greater among patients receiving BLS (13.1% vs 9.2% for ALS; 4.0 [95% CI, 2.3-5.7] percentage point difference), as was survival to 90 days (8.0% vs 5.4% for ALS; 2.6 [95% CI, 1.2-4.0] percentage point difference). Basic life support was associated with better neurological functioning among hospitalized patients (21.8% vs 44.8% with poor neurological functioning for ALS; 23.0 [95% CI, 18.6-27.4] percentage point difference). Incremental medical spending per additional survivor to 1 year for BLS relative to ALS was $154,333.

**CONCLUSIONS AND RELEVANCE** Patients with out-of-hospital cardiac arrest who received BLS had higher survival at hospital discharge and at 90 days compared with those who received ALS and were less likely to experience poor neurological functioning.
BACKGROUND
During cardiopulmonary resuscitation (CPR) in patients with out-of-hospital cardiac arrest, the interruption of manual chest compressions for rescue breathing reduces blood flow and possibly survival. We assessed whether outcomes after continuous compressions with positive-pressure ventilation differed from those after compressions that were interrupted for ventilations at a ratio of 30 compressions to two ventilations.

METHODS
This cluster-randomized trial with crossover included 114 emergency medical service (EMS) agencies. Adults with non–trauma-related cardiac arrest who were treated by EMS providers received continuous chest compressions (intervention group) or interrupted chest compressions (control group). The primary outcome was the rate of survival to hospital discharge. Secondary outcomes included the modified Rankin scale score (on a scale from 0 to 6, with a score of ≤3 indicating favorable neurologic function). CPR process was measured to assess compliance.

RESULTS
Of 23,711 patients included in the primary analysis, 12,653 were assigned to the intervention group and 11,058 to the control group. A total of 1129 of 12,613 patients with available data (9.0%) in the intervention group and 1072 of 11,035 with available data (9.7%) in the control group survived until discharge (difference, −0.7 percentage points; 95% confidence interval [CI], −1.5 to 0.1; P=0.07); 79% of the patients in the intervention group and 77% of those in the control group survived with favorable neurologic function at discharge (difference, −0.6 percentage points; 95% CI, −1.4 to 0.1, P=0.09). Hospital-free survival was significantly shorter in the intervention group than in the control group (mean difference, −0.2 days; 95% CI, −0.3 to −0.1; P=0.004).

CONCLUSIONS
In patients with out-of-hospital cardiac arrest, continuous chest compressions during CPR performed by EMS providers did not result in significantly higher rates of survival or favorable neurologic function than did interrupted chest compressions. (Funded by the National Heart, Lung, and Blood Institute and others; ROC CCC ClinicalTrials.gov number, NCT01372748.)
Intravenous Subdissociative-Dose Ketamine Versus Morphine for Analgesia in the Emergency Department: A Randomized Controlled Trial

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**Study objective:** We assess and compare the analgesic efficacy and safety of subdissociative intravenous-dose ketamine with morphine in emergency department (ED) patients.

**Methods:** This was a prospective, randomized, double-blind trial evaluating ED patients aged 18 to 55 years and experiencing moderate to severe acute abdominal, flank, or musculoskeletal pain, defined as a numeric rating scale score greater than or equal to 5. Patients were randomized to receive ketamine at 0.3 mg/kg or morphine at 0.1 mg/kg by intravenous push during 3 to 5 minutes. Evaluations occurred at 15, 30, 60, 90, and 120 minutes. Primary outcome was reduction in pain at 30 minutes. Secondary outcome was the incidence of rescue analgesia at 30 and 60 minutes.

**Results:** Forty-five patients per group were enrolled in the study. The primary change in mean pain scores was not significantly different in the ketamine and morphine groups: 8.6 versus 8.5 at baseline (mean difference 0.1; 95% confidence interval –0.46 to 0.77) and 4.1 versus 3.9 at 30 minutes (mean difference 0.2; 95% confidence interval –1.19 to 1.46; P=.97). There was no difference in the incidence of rescue fentanyl analgesia at 30 or 60 minutes. No statistically significant or clinically concerning changes in vital signs were observed. No serious adverse events occurred in either group. Patients in the ketamine group reported increased minor adverse effects at 15 minutes post-drug administration.

**Conclusion:** Subdissociative intravenous ketamine administered at 0.3 mg/kg provides analgesic effectiveness and apparent safety comparable to that of intravenous morphine for short-term treatment of acute pain in the ED. [Ann Emerg Med. 2015;66:222–229.]

Please see page 223 for the Editor’s Capsule Summary of this article.