CONFLICT OF INTEREST
ETCO2
The sixth vital sign: prehospital end-tidal carbon dioxide predicts in-hospital mortality and metabolic disturbances

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ARTICLE INFO
Article History:
Received 18 September 2013
Received in revised form 24 October 2013
Accepted 26 October 2013

ABSTRACT
Objective: To determine the ability of prehospital end-tidal carbon dioxide (ETCO2) to predict in-hospital mortality compared to conventional vital signs.

Methods: We conducted a retrospective cohort study among patients transported by emergency medical services during a 24-month period. Included patients had ETCO2 recorded in addition to initial vital signs. The main outcome was death at any point during hospitalization. Secondary outcomes included laboratory results and admitting diagnosis.

Results: Of 1,228 records reviewed, hospital discharge data, ETCO2, and all 8 prehospital vital signs were available in 1,086 patients. Low ETCO2 levels were the strongest predictor of mortality in the overall group (area under the receiver operating characteristic curve [AUC] 0.76; 95% confidence interval [CI] 0.69-0.83), as well as subgroup analysis excluding prehospital cardiac arrest (AUC of 0.77, 95% CI 0.67-0.87). The sensitivity of abnormal ETCO2 for predicting mortality was 93% (95% CI 79-98), the specificity was 44% (95% CI 31-58), and the negative predictive value was 59% (95% CI 52-66). There were significant associations between ETCO2 and serum bicarbonate levels (r = 0.429; p < 0.001), anion gap (r = -0.216; p < 0.001), and lactate (r = -0.377; p < 0.001).

Conclusion: Of all prehospital vital signs, ETCO2 was the most predictive and consistent for mortality, which may be related to an association with metabolic acidosis.

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1. Introduction

Vital signs are an integral part of initial patient assessment, and abnormal values are believed to predict poor patient outcomes. Well-established vital signs include temperature, pulse, blood pressure, respiration, and pulse oximetry. Exhaled end-tidal carbon dioxide (ETCO2) can be measured non-invasively by capnography and may provide further information regarding physiologic function.

ETCO2 is a continuous variable that is determined by basal metabolic rate, cardiac output, and ventilation [1]. Thus, abnormal levels may reflect derangement in perfusion, metabolism or gas exchange. It has multiple applications for monitoring of sedated patients [2], evaluation of proper endotracheal tube placement [3], and confirming return of spontaneous circulation during cardiopulmonary arrest [4]. Recent studies have suggested low ETCO2 levels are associated with disease severity and mortality in adult patients with shock [5], sepsis [6,7], and metabolic disturbances [8], as well as pediatric patients with diabetic ketoacidosis [9] and dehydration [10]. Additionally, low ETCO2 levels are associated with lactate levels [11], odds of operative intervention [12], and mortality [13] in trauma patients.

The purpose of this study is to investigate the clinical value of prehospital ETCO2 measurement as an outcome predictor compared to conventional vital signs in an undifferentiated sample of patients.

We hypothesize that abnormal ETCO2 levels will predict mortality and metabolic disturbances, acting as an additional vital sign that may improve prehospital risk stratification.

2. Methods

2.1. Design and setting

We conducted a retrospective cohort study among patients transported by a single emergency medical services (EMS) agency to a single hospital during a two and a half year period from January 2009 through July 2011 in Orange County, FL. The institutional review board at the participating hospital approved the study protocol.
Outcomes of Basic Versus Advanced Life Support for Out-of-Hospital Medical Emergencies

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Background: Most Medicare patients seeking emergency medical transport are treated by ambulance providers trained in advanced life support (ALS). Evidence supporting the superiority of ALS over basic life support (BLS) is limited, but some studies suggest ALS may harm patients.

Objective: To compare outcomes after ALS and BLS in out-of-hospital medical emergencies.

Design: Observational study with adjustment for propensity score weights and instrumental variable analyses based on county-level variations in ALS use.

Setting: Traditional Medicare.

Patients: 20% random sample of Medicare beneficiaries from nonrural counties between 2006 and 2011 with major trauma, stroke, acute myocardial infarction (AMI), or respiratory failure.

Measurements: Neurologic functioning and survival to 30 days, 90 days, 1 year, and 2 years.

Results: Except in cases of AMI, patients showed superior unadjusted outcomes with BLS despite being older and having more comorbidities. In propensity score analyses, survival to 90 days among patients with trauma, stroke, and respiratory failure was higher with BLS than ALS (6.1 percentage points [95% CI, 5.4 to 6.8 percentage points] for trauma; 7.0 percentage points [CI, 6.2 to 7.7 percentage points] for stroke; and 3.7 percentage points [CI, 2.5 to 4.8 percentage points] for respiratory failure). Patients with AMI did not exhibit differences in survival at 30 days but had better survival at 90 days with ALS (1.0 percentage point [CI, 0.1 to 1.9 percentage points]). Neurologic functioning favored BLS for all diagnoses. Results from instrumental variable analyses were broadly consistent with propensity score analyses for trauma and stroke, showed no survival differences between BLS and ALS for respiratory failure, and showed better survival at all time points with BLS than ALS for patients with AMI.

Limitation: Only Medicare beneficiaries from nonrural counties were studied.

Conclusion: Advanced life support is associated with substantially higher mortality for several acute medical emergencies than BLS.

Primary Funding Source: National Science Foundation, Agency for Healthcare Research and Quality, and National Institutes of Health.


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This article was published online first at www.annals.org on 13 October 2015.

The predominant response to out-of-hospital medical emergencies by ambulance providers in the United States is advanced life support (ALS) rather than basic life support (BLS). Advanced life support accounts for 65% of emergency medical care among Medicare beneficiaries (1) and even more among patients with high-acuity conditions, such as stroke. Ambulance crews using ALS are trained and equipped to provide sophisticated care on site ("stay and play"), whereas BLS emphasizes rapid transport to the hospital, so BLS ambulance crews provide only minimal treatment at the scene ("scoop and run") (2-4). Whereas ALS providers can use invasive interventions, such as endotracheal intubation for airway management and intravenous catheters for drug and fluid delivery, BLS providers use noninvasive interventions, such as bag valve masks for respiratory support. The ALS providers spend more time at the scene on average (3, 5-7) and receive higher reimbursement (8). Despite the predominance of ALS, the sparse evidence base does not support its benefits.

Because a randomized trial comparing ALS with BLS is unlikely, we conducted a large-scale observational study to compare survival and neurologic outcomes between Medicare beneficiaries with major trauma, stroke, acute myocardial infarction (AMI), or respiratory failure who received ALS versus BLS prehospital care.

Methods

Study Overview

We began by comparing unadjusted survival and neurologic functioning between patients receiving BLS and ALS. We then used 2 methodological approaches to address measured and unmeasured confounding.

See also:
Use of double sequential external defibrillation for refractory ventricular fibrillation during out-of-hospital cardiac arrest

Abstract

Introduction

Survival from out-of-hospital cardiac arrest (OHCA) is higher in victims with shockable rhythms when early CPR and rapid defibrillation are provided. However, a subset of individuals present with ventricular fibrillation (VF) that does not respond to defibrillation (re refractory VF). One intervention that may be a possible option in refractory VF is double sequential external defibrillation (DSED). The objective of this case series was to describe the outcomes of prehospital victims with refractory VF treated with DSED in the out-of-hospital setting.

Methods

This is a retrospective review of VF patients treated with DSED in the prehospital setting from August 1st, 2010 to June 30th, 2014. Patients were included if less than 11 years of age. The outcomes were evaluated on the number of patients with return of spontaneous circulation, conversion from VF, survival to hospital discharge, and Cardiac Performance Category score.

Results

Total of 2468 OHCA events were reviewed with twelve patients treated with DSED. Median DSED and prehospital resuscitation times were 17.98 min and 52.14 min, respectively, of the 14 patients treated.

Preliminary Report

DOUBLE SEQUENTIAL EXTERNAL DEBIRILLATION IN OUT-OF-HOSPITAL REFRACTORY VENTRICULAR FIBRILLATION: A REPORT OF TEN CASES

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Background: Refractory ventricular fibrillation (VF) during cardiopulmonary arrest greatly impacts outcomes. The use of a double sequential external defibrillation technique has been reported to improve VF conversion. This report describes the outcomes of out-of-hospital VF patients who were treated with double sequential external defibrillation.

Methods: This is a retrospective study of all OHCA patients treated with double sequential external defibrillation in the prehospital setting at a tertiary care center. The study period was from January 1, 2010 to December 31, 2014. The outcomes were evaluated on the number of patients with return of spontaneous circulation, conversion from VF, survival to hospital discharge, and Cardiac Performance Category score.

Results: Of the 2468 OHCA events, 12 patients received double sequential external defibrillation. The median age was 36 years (range: 17-80), and the median time to defibrillation was 17.98 min (range: 5-45). The median survival to hospital discharge was 52.14 min (range: 5-45). The Cardiac Performance Category score was 2.8 (range: 2-4).

Conclusion: Double sequential external defibrillation is a promising technique for treating refractory VF during out-of-hospital cardiac arrest.

Double sequential external shocks for refractory ventricular fibrillation

Clinical study

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Abstract

Objectives: A technique for terminating refractory ventricular fibrillation is described.

Methods: Five patients with refractory ventricular fibrillation were treated with double sequential external defibrillation. Multiple shocks were delivered by means of a single defibrillator. Conversion was defined as the loss of fibrillatory activity.

Results: In all patients, standard defibrillation was unsuccessful, but all were successfully resuscitated using the double sequential shocks.
Use of double sequential external defibrillation for refractory ventricular fibrillation during out-of-hospital cardiac arrest

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Abstract

Introduction
Survival from out-of-hospital cardiac arrest (OHCA) is highest in victims with shockable rhythms when early CPR and rapid defibrillation are provided. However, a subset of individuals present with ventricular fibrillation (VF) that does not respond to defibrillation. VF: One intervention that may be a possible option in refractory VF is double sequential external defibrillation (DSD). The objective of this case series was to describe the outcomes of prehospital victims with refractory VF treated with DSD in the out-of-hospital setting.

Methods
This evaluation is a retrospective chart review of VF patients treated with DSD in the prehospital setting from August 1st, 2010 through June 30th, 2014. Patients were excluded if less than 11 years of age. The outcomes were evaluated using the number of patients with return of spontaneous circulation, conversion from VF, survival to hospital discharge, and Central Performance Category score.

Results
Total of 2428 OHCA events were reviewed, with twelve patients treated with DSD. Median DSD and prehospital survival was 74 years old and 32 years old, respectively. Of the 12 patients treated.

Preliminary Report

Double sequential external shocks for refractory ventricular fibrillation

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Abstract

Objectives. A technique for terminating refractory ventricular fibrillation is described.

Background. Refractory ventricular fibrillation can occur in up to 0.1% of electrophysiology studies. Animal studies have shown that rapid sequential shocks may reduce ventricular fibrillation threshold.

Methods. Five patients of 2,990 consecutive patients in a 3-year period experienced refractory ventricular fibrillation during 5,450 routine electrophysiology studies. Multiple shocks were delivered by means of a single defibrillator. Double sequential shocks were delivered externally 0.5 to 4.5 s apart by means of two defibrillators with separate pairs of electrodes.

Results. In all patients, standard defibrillation was unsuccessful, but all were successfully resuscitated using the double sequential shocks.

Contents lists available at ScienceDirect

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Sepsis
The Prehospital Sepsis Project: Out-of-Hospital Physiologic Predictors of Sepsis Outcomes

Amado Alejandro Baz, MD; Priscilla Hanudel, MD; Susan Renee Wilcox, MD

Abstract

Introduction: Severe sepsis and septic shock are common, expensive and often fatal medical problems. The care of the critically sick and injured often begins in the prehospital setting; there is limited data available related to predictors and interventions specific to sepsis in the prehospital arena. The objective of this study was to assess the predictive effect of physiologic elements commonly reported in the out-of-hospital setting in the outcomes of patients transported with sepsis.

Methods: This was a cross-sectional descriptive study. Data from the years 2004-2006 were collected. Adult cases (≥18 years of age) transported by Emergency Medical Services to a major academic center with the diagnosis of sepsis as defined by ICD-9-CM diagnostic codes were included. Descriptive statistics and standard deviations were used to present group characteristics. Chi-square was used for statistical significance and odds ratios (OR) to assess strength of association. Statistical significance was set at the .05 level.

Physiologic variables studied included mean arterial pressure (MAP), heart rate (HR), respiratory rate (RR) and shock index (SI).

Results: Sixty-three (63) patients were included. Outcome variables included a mean hospital length of stay (HLOS) of 13.75 days (SD = 9.97), mean ventilator days of 4.93 (SD = 7.87), in-hospital mortality of 22 of 63 (34.9%), and mean intensive care unit length of stay (ICU-LOS) of 7.02 days (SD = 7.98). Although SI and RR were found to predict intensive care unit (ICU) admissions, [OR 5.96, CI: 1.49-25.78, P = .003] and [OR 4.81, CI: 1.16-21.01, P = .0116], respectively, none of the studied variables were found to predict mortality (MAP <65 mmHg. HR >90, RR >20, P = .31, SI >0.7 P = .35).

Conclusions: This study demonstrated that the out-of-hospital shock index and respiratory rate have high predictability for ICU admission. Further studies should include the development of an out-of-hospital sepsis score.


Introduction

Severe sepsis and septic shock are common and expensive medical problems. With an estimated incidence of 751,000 cases (1.0 per 1000 population) in the United States each year, severe sepsis and septic shock are associated with significant mortality and consumption of health care resources with estimated costs of US $16.7 billion dollars annually. Although the case fatality rate has declined, with the aging of the population, the incidence of severe sepsis has increased and is expected to continue to increase, making sepsis care a critical issue.

The initial component of the sepsis continuum is the systemic inflammatory response syndrome (SIRS). As a pro-inflammatory state, SIRS is associated with clinical findings that include tachycardia, tachypnea, alterations in white cell count, and thermal dysregulation. Sepsis, defined as SIRS with a suspected or confirmed source of infection, may progress rapidly to severe sepsis and septic shock, characterized by hypoperfusion, with hypotension, oliguria, and altered mental status, culminating in multi-organ failure.
Association of Fluid Resuscitation Initiation Within 30 Minutes of Severe Sepsis and Septic Shock Recognition With Reduced Mortality and Length of Stay

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Study objective: We evaluate the association of intravenous fluid resuscitation initiation within 30 minutes of severe sepsis or septic shock identification in the emergency department (ED) with inhospital mortality and hospital length of stay. We also compare intravenous fluid resuscitation initiated at various times from severe sepsis or septic shock identification’s association with the same outcomes.

Methods: This was a review of a prospective, observational cohort of all ED severe sepsis or septic shock patients during 13 months, captured in a performance improvement database at a single, urban, tertiary care facility (95,000 ED visits/year). The primary exposure was initiation of a crystalloid bolus at 30 mL/kg within 30 minutes of severe sepsis or septic shock identification. Secondary analysis compared intravenous fluid initiated within 30, 31 to 60, or 61 to 180 minutes, or when intravenous fluid resuscitation was initiated at greater than 180 minutes or not provided.

Results: Of 1,856 subjects, 53.6% were men, 72.5% were white, mean age was 72 years (SD 16.6 years), and mean initial lactate level was 2.8 mmol/L. Eighty percent of subjects were administered intravenous antibiotics within 180 minutes; 1,193 (63%) had intravenous fluid initiated within 30 minutes. Mortality was lower in the within 30 minutes group (159 [13.3%] versus 123 [18.3%]; 95% confidence interval [CI] 1.4% to 8.8%), as was median hospital length of stay (6 days [95% CI 6 to 7] versus 7 days [95% CI 7 to 8]). In multivariate regression that included adjustment for age, lactate, hypotension, acute organ dysfunction, and Emergency Severity Index score, intravenous fluid within 30 minutes was associated with lower mortality (odds ratio 0.63; 95% CI 0.46 to 0.86) and 12% shorter length of stay (hazard ratio=1.14; 95% CI 1.02 to 1.27). In secondary analysis, mortality increased with later intravenous fluid resuscitation initiation: 13.3% (≤30 minutes) versus 18.0% (31 to 60 minutes) versus 16.9% (61 to 180 minutes) versus 19.7% (>180 minutes). Median hospital length of stay also increased with later intravenous fluid resuscitation initiation: 6 days (95% CI 6 to 7 days) versus 7 days (95% CI 6 to 7 days) versus 8 days (95% CI 7 to 9 days).

Conclusion: The time of intravenous fluid resuscitation initiation was associated with improved mortality and could be used as an easier obtained alternative to intravenous fluid resuscitation completion time as a performance indicator in severe sepsis and septic shock management. [Ann Emerg Med. 2016;68:298-311.]

Please see page 299 for the Editor’s Capsule Summary of this article.
MEDICAL ERROR would be the 3rd leading killer in the U.S. per year

- 599,000: Heart Disease
- 568,000: Cancer
- 187,000: Medical Error
- 137,000: Chronic Lower Respiratory Disease
- 129,000: Stroke
- 118,000: Accidents

source: cdc.gov; Health Affairs

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TO ERR IS HUMAN: BUILDING A SAFER HEALTH SYSTEM

Health care in the United States is not as safe as it should be—and can be. At least 44,000 people, and perhaps as many as 98,000 people, die in hospitals each year as a result of medical errors that could have been prevented, according to estimates from two major studies. Even using the lower estimate, preventable medical errors in hospitals exceed attributable deaths to such feared threats as motor-vehicle wrecks, breast cancer, and AIDS.

Medical errors can be defined as the failure of a planned action to be completed as intended or the use of a wrong plan to achieve an aim. Among the problems that commonly occur during the course of providing health care are adverse drug events and improper transfusions, surgical injuries and wrong-site surgery, suicides, restraint-related injuries or death, falls, burns, pressure ulcers, and mistaken patient identities. High error rates with serious consequences are most likely to occur in intensive care units, operating rooms, and emergency departments.

Beyond their cost in human lives, preventable medical errors exact other significant tolls. They have been estimated to result in total costs (including the expense of additional care necessitated by the errors, lost income and household productivity, and disability) of between $17 billion and $29 billion per year in hospitals nationwide. Errors also are costly in terms of loss of trust in the health care system by patients and diminished satisfaction by both patients and health professionals. Patients who experience a long hospital stay or disability as a result of errors pay with physical and psychological discomfort. Health professionals pay with loss of morale and frustration at not being able to provide the best care possible. Society bears the cost of errors as well, in terms of lost worker productivity, reduced school attendance by children, and lower levels of population health status.

A variety of factors have contributed to the nation’s epidemic of medical errors. One oft-cited problem arises from the decentralized and fragmented nature of the health care delivery system—or “nonsystem,” to some observers. When patients see multiple providers in different settings, none of...
PARAMEDIC SELF-REPORTED MEDICATION ERRORS

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ABSTRACT

Background. Continuing quality improvement (CQI) reviews reflect that medication administration errors occur in the prehospital setting. These include errors involving dose, medication, route, concentration, and treatment. Methods. A survey was given to paramedics in San Diego County. The survey tool was established on the basis of previous literature reviews and questions developed with previous CQI data. Results. A total of 352 surveys were returned, with the paramedics reporting an average of 8.5 years of field experience. They work an average of 11.0 shifts/month with an average of 25.4 hours and 6.7 calls/shift. Thirty-two (9.1%) responding paramedics reported committing a medication error in the last 12 months. Types of errors included dose-related errors (65%), protocol errors (33%), wrong route errors (21%), and wrong medication errors (4%). Issues identified in contributing to the errors include failure to triple check, infusion use of the medication, dosage calculation error, and incorrect dosage given. Fatigue, training, and equipment setup of the drug box were not listed as any of the contributing factors. The majority of these errors were self-reported to their CQI representative (71%), with 8.3% being reported by the base hospital radio nurse, 8.5% found upon chart review, and 4.2% noted by paramedic during call but never reported. Conclusions. Nine percent of paramedics responding to an anonymous survey report medication errors in the last 12 months, with 4% of these errors never having been reported in the CQI process. Additional safeguards must continue to be implemented to decrease the incidence of medication errors.

PREHOSPITAL EMERGENCY CARE 2007;11:80-84

INTRODUCTION

The landmark 1999 Institute of Medicine report To Err is Human: Building a Safer Health System2 drew national attention to the serious morbidity and mortality associated with adverse drug events. The estimate that “at least 44,000 and perhaps 98,000 Americans die in hospitals each year as a result of medical errors”2 highlighted the gravity of this problem.

Following this report many hospitals introduced new safeguards to protect patients from these errors2. Accreditation agencies, such as the Joint Commission on Accreditation of Health Care Organizations (JCAHO), are now requiring hospitals to report adverse drug events. Legislation to make error reporting mandatory has been proposed.3 However, medication errors continue to be common. A recent study of 36 health care facilities reported that medication errors occur in “1 in 3 for nearly one of every five doses in the typical site.”4 Most of this scientific literature documenting medication errors deals with in-hospital errors.5 Consequently, many of the laws and requirements aimed at preventing these errors are changes made within the hospital system. However, there exists a distinct subset of medication errors that occur in the prehospital treatment of patients.

Several case reports have documented significant injury and even fatalities as a result of prehospital medication error.6,7 Many institutions have a method for reporting these errors. The Continuing Quality Improvement (CQI) process for the County of San Diego prehospital system reflects that medication administration errors do occur in the prehospital setting. These include incorrect dose, medication, route, concentration, and/or wrong indications. However, to date, there exists no large-scale study examining the prevalence of prehospital medication errors. We sought to characterize paramedic perceived and self-reported medication errors in this urban, suburban, and rural EMS system.

MATERIALS AND METHODS

This study is a survey given to paramedics in our county at the time of their annual protocol update training (Figure 1). It was distributed at the end of training sessions. The survey tools contained no names or other identifying numbers that might make the paramedic feel that the survey could be linked back to him or her. The goal was a blinded, anonymous survey to optimize...
ASSOCIATION BETWEEN POOR SLEEP, FATIGUE, AND SAFETY OUTCOMES IN EMERGENCY MEDICAL SERVICES PROVIDERS

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Abstract

Objectives: To determine the association between poor sleep quality, fatigue, and safety outcomes among emergency medical services (EMS) providers. Methods: We conducted a cross-sectional study of 3,282 EMS providers from 30 EMS agencies across the United States. Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI), fatigue was measured using the Fatigue Severity Scale (FSS), and safety outcomes were measured using the National EMS Injury Reporting System (NEMSIS) database. Results: Respondents reported a mean PSQI score of 7.3 and a mean FSS score of 3.8. The prevalence of moderate-high fatigue was 70.5%. The prevalence of safety-related incidents was 0.6% (95% CI, 0.52-0.73). In a multivariable regression analysis, poor sleep quality (adjusted OR, 1.5; 95% CI, 1.21-1.83) and fatigue (adjusted OR, 1.6; 95% CI, 1.25-2.05) were independently associated with safety-related incidents. Conclusions: Poor sleep quality and fatigue are common among EMS providers and are independently associated with safety-related incidents. These findings suggest that interventions to improve sleep quality and reduce fatigue could reduce the risk of safety-related incidents in EMS providers.

INTRODUCTION

Poor sleep quality and fatigue among health care workers contribute to poor patient outcomes and increased costs of care. The National Health Interview Survey estimated that 27% of Americans report not getting enough sleep. In a study of 5,000 emergency medical technicians, 40% reported not getting enough sleep. The prevalence of moderate-high fatigue was 70.5%. The prevalence of safety-related incidents was 0.6% (95% CI, 0.52-0.73). In a multivariable regression analysis, poor sleep quality (adjusted OR, 1.5; 95% CI, 1.21-1.83) and fatigue (adjusted OR, 1.6; 95% CI, 1.25-2.05) were independently associated with safety-related incidents. These findings suggest that interventions to improve sleep quality and reduce fatigue could reduce the risk of safety-related incidents in EMS providers.

THE SHIFT LENGTH, FATIGUE, AND SAFETY COMORPHISM IN EMS

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Shift length and fatigue among emergency medical services (EMS) providers may increase error and injury.1-9 Shift work is invariable given the constant need for EMS, but the ideal length of shifts and rest intervals is uncertain. Are eight-hour shifts that rotate every 30 days (e.g., 0700-1500, 1500-2300, 2300-0700) really superior to 24-hour-on, 48-hour-off schedule? Is a 24-hour shift with low call volume worse than an eight- or 12-hour shift with high call volume? How are we to address providers who work consecutive shifts at more than one EMS agency? Many EMS view these questions from different perspectives. Some point to longer shifts as necessary to achieve better-costing models related to staffing, a compressed workforce, and the flexibility to have more time with family or a second job. Others may presume that longer shifts can only lead to poor care or poor provider health. There's limited support for or against different perspectives because of a lack of data generated from studies of EMS clinicians. We seek to form a common frame of reference for debate and decision making at all levels toward development of EMS shift and rest approaches. We propose that four essential questions help frame the issues related to fatigue and safety in EMS.

ESSENTIAL QUESTIONS

1. “Do extended shift structures in EMS result in fatigue and/or negative safety outcomes?”

EMS shift lengths often mirror the line-service model of longer shift lengths instead of the law-enforcement model of rotating eight-hour shifts. Twelve- and 24-hour shifts are common shift structures in EMS.10 One-third of EMS clinicians accumulate extended shift hours by ending a shift at one agency to begin another shift at a second EMS organization.11 Some may believe that extended shifts (≥12 hours) result in poor sleep and fatigue that contribute to negative patient or provider outcomes (Fig. 1).

The theory in Figure 1 poses a mediation model, where shift length alters outcomes by increasing fatigue. Support for the mediation model between EMS worker shift length, fatigue, and safety outcomes is limited by an absence of data. Testing the model in Figure 1 is limited by several factors. First, it is difficult to define shift work in EMS providers. Shift work broadly refers to any arrangement of daily working hours other than standard daily hours (7 AM-5 PM).12 Fatigue and decreased work performance vary by service mode, duration of shift, method of rotation, duration of rotation, regularity/irregularity, and number of rest-days/weeks. Second, the amount of work an EMS clinician/crew performs in a given shift also varies and has the potential to impact the relationships in Figure 1. Third, many EMS clinicians work voluntary or mandatory (“forced”) overtime, work shifts that rotate forwards or backwards, or are employed with second jobs sometimes within and outside the public safety sector.12 All of this complicates the definitions and assessments of impact.

Received May 31, 2012, from the Department of Emergency Medicine, University of Pittsburgh School of Medicine, Pittsburgh, Pennsylvania. Revision received June 17, 2012, accepted for publication June 17, 2012.

The authors report no conflicts of interest with this research study and manuscript.

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The National EMS Advisory Council

Final Advisory

Adopted on January 30, 2013

Committee: Safety
Title: Fatigue in Emergency Medical Services

A: Problem Statement

There is reason to believe that a high proportion of Emergency Medical Services (EMS) workers suffer from fatigue, and as a result, poor safety outcomes. Poor sleep, which is a precursor to short term or chronic fatigue, affects between 29% and 35% of U.S. adults. Fatigue affects one in every four U.S. workers (38%; 95% CI 37.4, 38.5). Poor sleep and fatigue can reduce attention, impair normal functions of the central nervous system, and have a negative impact on cognition, reaction time, and health. Furthermore, research has identified a strong association between poor sleep, fatigue, poor safety outcomes, and risks to long-term health. There is limited research that examines fatigue and poor sleep among EMS providers. However, there is widespread concern that EMS providers and patients are at an increased risk of poor safety outcomes related to fatigue. Factors believed to increase this risk include the atypical work schedule (shift work), providers holding multiple jobs with risks of chronic fatigue syndromes, unpredictable nature of EMS call volume which affects ability to rest, increased need and demand for EMS responses tied to increased productivity requirements limiting opportunities for rest, a high prevalence of poor sleep and fatigue among EMS workers, a high prevalence of occupational stress and burnout, poor health status among EMS workers, high risk of occupational injury and mortality, and wide variation in workplace safety culture. EMS is a vital public health resource, providing care for more than 30 million ill and injured patients annually. Poor sleep and fatigue among EMS workers represent potential threats to patient care, provider wellbeing, and the public’s health and trust in EMS.

The overarching goals of this advisory are to:

1. provide a brief summary of current research regarding fatigue and its impact on safety and to highlight gaps in the research, evidence and current efforts to address the observed problems of fatigue and safety; and

2. advise NHTSA to address a list of feasible recommendations for combating the impact of fatigue on EMS patient and provider safety.
Remote Ischemic Conditioning

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ABSTRACT

Remote ischemic conditioning (RIC), brief, reversible episodes of ischemia with reperfusion in one vascular bed, tissue, or organ confer a global protective phenotype and render remote tissues and organs resistant to ischemia/reperfusion injury. The peripheral stimulus can be chemical, mechanical, or electrical and involves activation of peripheral sensory nerves. The signal transfer to the heart or other organs is through neuronal and humoral communications. Protection can be transferred, even across species, with plasma-derived dialysate and involves nitric oxide, stromal derived factor-1α, microribonucleic acid-146, but also other, not yet identified factors. Intracardiac signal transduction involves: adenosine, bradykinin, cytokines, and chemokines, which activate specific receptors; intracellular kinases; and mitochondrial function. RIC by repeated brief inflation/deflation of a blood pressure cuff protects against endothelial dysfunction and myocardial injury in percutaneous coronary interventions, coronary artery bypass grafting, and reperfused acute myocardial infarction. RIC is safe and effective, noninvasive, easily feasible, and inexpensive. (J Am Coll Cardiol 2015;65:177-95) © 2015 by the American College of Cardiology Foundation.

Remote ischemic conditioning (RIC) is the intriguing phenomenon whereby brief, reversible episodes of ischemia and reperfusion applied in one vascular bed, tissue, or organ confer global protection, rendering remote tissues and organs resistant to ischemia/reperfusion injury. Its discovery 2 decades ago in the heart (1) was not serendipitous, but evolved from a mathematical model developed by Whittaker and Przyklenk (2-4), in which brief episodes of pre-conditioning ischemia in one coronary bed were predicted to trigger activation, release, or transport of one or more unknown “protective factors” throughout the myocardium. To test this hypothesis, anesthetized dogs underwent 4 episodes of 5-min ischemia applied in the left circumflex coronary territory, followed by a 1-h sustained ischemic insult in the left anterior descending coronary artery bed. As anticipated, compared with control subjects that underwent left anterior descending occlusion alone, animals that received brief antecedent episodes of circumflex occlusion before sustained left anterior descending occlusion displayed a robust reduction of infarct size (1).
Remote ischaemic conditioning before hospital admission, as a complement to angioplasty, and effect on myocardial salvage in patients with acute myocardial infarction: a randomised trial


Summary

Background Remote ischaemic preconditioning attenuates cardiac injury at elective surgery and angioplasty. We tested the hypothesis that remote ischaemic conditioning during early (within 30 min) reperfusion of myocardial infarction, and done before primary percutaneous coronary intervention, increases myocardial salvage.

Methods 331 consecutive adult patients with a suspected first acute myocardial infarction were randomly assigned in a 1:1 ratio by computerized block randomization to receive primary percutaneous coronary intervention with a stent (pseudo-patients) versus without (pseudo-re), remote conditioning (interrupted arm ischemia through four cycles of 5 min inflation and 5 min deflation of a blood-pressure cuff) Allocation was concealed with opaque sealed envelopes. Patients received remote conditioning during transport to hospital, and primary percutaneous coronary intervention in hospital. The primary endpoint was myocardial salvage index at 30 days after primary percutaneous coronary intervention, measured by myocardial perfusion imaging as the proportion of the area at risk salvaged by treatment; analysis was per protocol. This study is registered with ClinicalTrials.gov, number NCT01493126.

Findings 32 patients were excluded on arrival at hospital because they did not meet inclusion criteria. 32 were lost to follow-up, and 77 did not complete the follow-up with data for salvage index. Median salvage index was 0.79 (IQR 0.59-9.59, N=72) in the remote conditioning group versus 0.55 (IQR 0.35-0.58, N=71) in the control group, with median difference of 0.19 (95% CI 0.01-0.38, p=0.03); mean salvage index was 0.69 (SD 0.27) versus 0.57 (SD 0.20), with mean difference of 0.12 (95% CI 0.03-0.30, p=0.03). Major adverse coronary events were death (3% per group), recurrent infarction (10% per group), and heart failure (6% per group).

Interpretation Remote ischaemic conditioning before hospital admission increases myocardial salvage, and has a favorable safety profile. Our findings merit a larger trial to establish the effect of remote conditioning on clinical outcomes.

Funding Foundation Leaard.

Introduction

ST-elevation myocardial infarction is a leading cause of mortality and morbidity. Intermittent reperfusion of myocardial injury is a therapeutic mainstay, best achieved by early reperfusion through primary percutaneous coronary intervention.1 Patients receiving such treatment will achieve infarct-related vessel patency and reperfusion, but risk sustaining clinically significant myocardial infarction, even when the procedure is done soon after symptom onset.2 Attempts to improve outcomes with adjuvant mechanical treatments such as thrombectomy and distal protection devices show inconsistent benefit.3 An alternative approach for treatment is to exploit innate countermechanisms. Findings from recent studies of local preconditioning and targeting of mitochondrial pathways in myocardial infarction have indicated success in reduction of infarct size in patients with occluded left anterior descending artery.4 Remote ischaemic preconditioning, induced by repeated brief periods of limited ischemia before index ischemia,5 reduces myocardial injury in patients exposed to predictable ischemia.6 Furthermore, remote ischemic postconditioning, applied in the early reperfusion phase after prolonged ischemia, seems to be more effective than local preconditioning in experimental myocardial infarction.7 We have shown that conditioning, by interrupted limb ischemia after the onset of myocardial ischemia and before reperfusion, reduces infarct size in a porcine model.8 This simple technique can be used during hospital transport.

We used myocardial perfusion imaging to examine whether remote ischaemic conditioning done before primary percutaneous coronary intervention increases myocardial salvage, a predictor of mortality, in patients with a first acute and evolving myocardial infarction.

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Jr Eardley Award 2011

See page 218 for editorial comment on this article (doi:10.1016/j.heart.2010.07.007)
Prehospital Neuroprotective Therapy for Acute Stroke
Results of the Field Administration of Stroke Therapy–Magneimsium (FAST–MAG) Pilot Trial

Jeffrey L. Saver, MD; Chelsea Kidwell, MD; Marc Eckstein, MD; Sidney Starkman, MD; for the FAST–MAG Pilot Trial Investigators

Background and Purpose—To demonstrate that paramedic initiation of intravenous magnesium sulfate (Mg) in the field in focal stroke patients is feasible, safe, and yields significant time-savings compared with in-hospital initiation of neuroprotective therapy.

Methods—We performed an open-label clinical trial. Inclusion criteria were: (1) likely stroke as identified by the Los Angeles Prehospital Stroke Screen; (2) age 45 to 95; and (3) treatment initiation within 12 hours of symptom onset. Paramedics initiated 4 g Mg loading dose in the field, followed by 16 g over 24 hours in hospital.

Results—Twenty patients were enrolled, with mean age 74 (range 44 to 92), and 50% were male. Final diagnosis was acute cerebrovascular disease in all (ischemic 80%, hemorrhagic 20%). Study agent infusion began a median of 100 minutes after symptom onset (range 24 to 703), and 70% received study agent within 2 hours of onset. The interval from paramedic arrival on scene to study agent start was field-initiated, 26 minutes (range 15 to 64) versus in-hospital initiated (historic controls), 139 minutes (range 66 to 300), \( p < 0.0001 \). Paramedics rated patient status on hospital arrival as improved 20%, worsened 5%, and unchanged 75%. Median NIHSS on hospital arrival was 11 in all patients and 16 in patients unchanged since field treatment start. Good functional outcome at 3 months (Rankin \( \leq 2 \)) occurred in 60%. No serious adverse events were associated with field therapy initiation.

Conclusions—Field initiation of Mg sulfate in acute stroke patients is feasible and safe. Prehospital trial conduct substantially reduces on-scene to needle time and permits hyperacute delivery of neuroprotective therapy. (Stroke. 2004; 35:e106-e108.)

Key Words: stroke ■ neuroprotection ■ emergency medical services ■ clinical trials

Neuroprotective therapies interrupt the biochemical, cellular, and metabolic elaboration of injury in ischemic environments and are promising acute stroke interventions. 1 Delayed time to delivery of experimental therapy has hindered past human neuroprotection in clinical trials. 1–3 The Field Administration of Stroke Therapy–Magneimsium (FAST–MAG) Pilot Trial was performed to investigate the feasibility, safety, and achievable time-savings of paramedic initiation of magnesium sulfate neuroprotective therapy for patients with acute stroke.

Methods
This was a nonrandomized, open-label, phase 2, feasibility clinical trial. The target population was patients with acute, ambulance-transported stroke, both ischemic and hemorrhagic. Inclusion criteria were: (1) suspected stroke identified by the Los Angeles Prehospital Stroke Screen (LAPSS); (2) age 45 to 95; and (3) last known well time \( \geq 15 \) minutes and \( \leq 12 \) hours of treatment initiation.

Exclusion criteria were: (1) recent trauma; (2) seizure disorder; (3) known chronic renal impairment; (4) coma; (5) respiratory distress; (6) systolic blood pressure <90 or >220; (7) woman of child-bearing age; (8) recent stroke within past 30 days; and (9) rapidly resolving deficit.

All patients transported by 3 UCLA-based Los Angeles Fire Department ambulances were screened. Each ambulance carried written informed consent forms and a dedicated FAST–MAG cellular phone. In nontrauma, noncomatose patients reporting symptoms of possible neurologic origin, paramedics performed the Los Angeles Prehospital Stroke Screen, an 8-item, 1- to 2-minute stroke screening inventory. 3–4 When patients met LAPSS screening criteria, paramedics contacted an on-call physician-investigator. By phone, the physician-investigator reviewed the patient presentation, performed final determination of study eligibility, and elicited informed consent.

All enrolled patients received active magnesium sulfate (Mg). Paramedics initiated a loading dose in the field, administering a prefilled syringe containing 2.5 g Mg in 5 ml normal saline (Abboplex; Abbott Laboratories) by slow intravenous push over 10 minutes. Emergency department staff administered the remainder of Mg.
Early fluid resuscitation in severe trauma

Tim Harris professor of emergency medicine, O O Rhys Thomas, Lieutenant Colonel and honorary consultant, *Karin Bicki* professor of trauma sciences and consultant trauma and vascular surgeon

There is a global health priority that targets patients in both high- and middle-income countries. Early death is the second leading cause of death; the World Health Organization (WHO) estimates that 3.3 million deaths each year are due to trauma. *Early death* is defined as trauma-related death before definitive medical intervention. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related injuries. *Early death* is defined as death from trauma-related 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What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation?


Background: The 2010 international guidelines for CPR recently recommended an increase in the minimum compression depth from 30 to 50 mm, although there are limited human data to support this. We sought to study patterns of CPR compression depth and their...

The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the Resuscitation Outcomes Consortium PRIMED trial


Background: Previous research has demonstrated significant relationships between peri-shock pause and survival to discharge from out-of-hospital shockable cardiac arrest (OHCA). Objective: To determine the impact of peri-shock pause on survival from OHCA...

Epidemiology and outcomes from out-of-hospital cardiac arrest in children: The Resuscitation Outcomes Consortium Epilepsy-Cardiac Arrest study

Resuscitation Outcomes Consortium Investigators - Circulation, 2009 - amheartassoc.org

Background: Population-based data for pediatric cardiac arrest are scant and largely from urban areas. The Resuscitation Outcomes Consortium (ROC) Epilepsy-Cardiac Arrest is a population-based emergency medical services registry of out-of-hospital nontraumatic...

Receiving hospital characteristics associated with survival after out-of-hospital cardiac arrest

E. Nichol, Resuscitation Outcomes Consortium - Resuscitation, 2010 - elsevier.com

AIM: Survival after out-of-hospital cardiac arrest (OHCA) varies between regions, but the contribution of different factors to this variability is unknown. This study examined whether survival to hospital discharge was related to receiving hospital characteristics, including...

... of automatic external defibrillators before arrival of the emergency medical system: evaluation in the Resuscitation Outcomes Consortium population of 21

M. Wellsted, G. Sillian, J.P. Omoto - Journal of the American College of Cardiology, 2010 - aacc.org

Objectives: The purpose of this study was to assess the effectiveness of contemporary automatic external defibrillators (AED) used in the prehospital period. Background: The Public Access Defibrillation (PAD) trial survival was doubled by focused training of lay volunteers to use an AED...

Rationale, development and implementation of the Resuscitation Outcomes Consortium Epilepsy-Cardiac Arrest study


OBJECTIVE: To describe the development, design and consequent scientific implications of the Resuscitation Outcomes Consortium (ROC) population-based registry. Epilepsy-Cardiac Arrest: METHODS: The ROC Epilepsy-Cardiac Arrest is designed as a...

Resuscitation Outcomes Consortium Investigators - Circulation, 2009 - amheartassoc.org

Conclusions: In patients with out-of-hospital cardiac arrest, CPR strategy of continuous chest compressions with positive pressure ventilation as compared with chest compressions interrupted for ventilation by EMS providers did not significantly improve survival or...

Chest compression fraction determines survival in patients with out-of-hospital ventricular fibrillation

Resuscitation Outcomes Consortium Investigators - Circulation, 2009 - amheartassoc.org

Background: Quality cardiopulmonary resuscitation contributes to cardiac arrest survival. The proportion of time in which chest compressions are performed in each minute of cardiopulmonary resuscitation is an important modifiable aspect of quality...

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Thanks For Listening
Improved long-term clinical outcomes in patients with ST-elevation myocardial infarction undergoing remote ischaemic conditioning as an adjunct to primary percutaneous coronary intervention

Astrid D. Sloth, Michael R. Schmidt, Kim Munk, Rajesh K. Kharbanda, Andrew N. Redington, Morten Schmidt, Lars Pedersen, Henrik T. Sørensen, and Hans Erik Batker, CONDI Investigators

Aims
Remote ischaemic conditioning as an adjunct to primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction increases primary outcome.

Methods and results
From February 2007 to November 2008, 333 patients with a suspected acute ST-elevation myocardial infarction were randomized to receive primary percutaneous coronary intervention with (n = 164) or without (n = 167) remote ischaemic conditioning. Independent arm echocardiography after primary percutaneous coronary intervention was performed to confirm the diagnosis. The primary endpoint was major adverse cardiac and cerebrovascular events (MACCE)—a composite of all-cause mortality, myocardial infarction, readmission for heart failure, and ischemic end-organ damage. The individual components of the primary endpoint comprised the secondary end-

See page 188 for the editorial comment on this article (doi:10.1093/eurheartj/het179)