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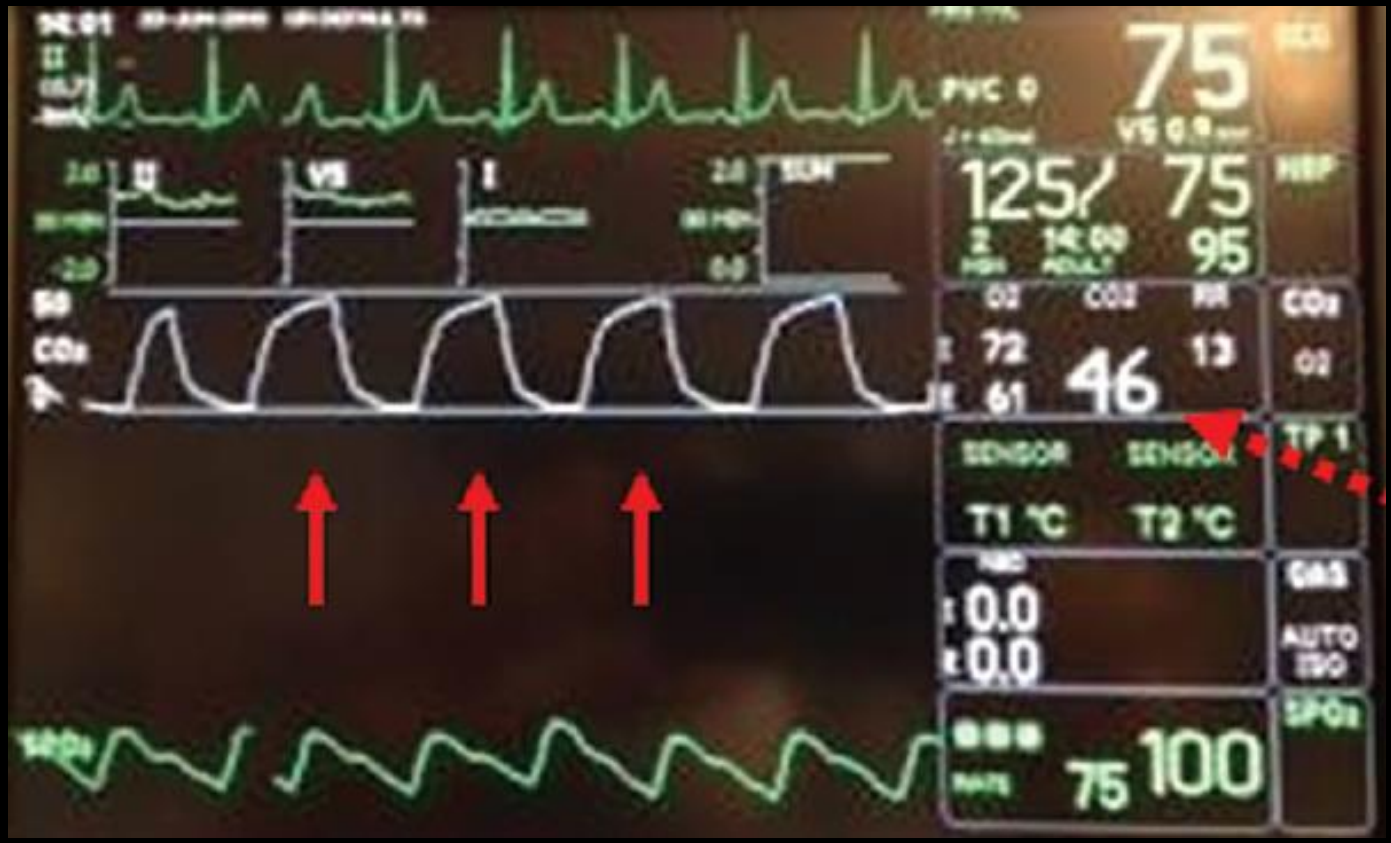
CONFLICT
OF
INTEREST

ETCO2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Brief Report

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

Christopher L. Hunter, MD, PhD [a,b,*], Salvatore Silvestri, MD [a,b], George Ralls, MD [a,b], Steven Bright, MD [b], Linda Papa, MD, MSc [a]

[a] Department of Emergency Medicine, Orlando Regional Medical Center, Orlando, FL, USA
[b] University of Central Florida College of Medicine, Orlando, FL, USA

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ABSTRACT

Objective: To determine the ability of prehospital end-tidal carbon dioxide ($ETCO_2$) 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 29-month period. Included patients had $ETCO_2$ 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 1328 records reviewed, hospital discharge data, $ETCO_2$, and all 6 prehospital vital signs were available in 1088 patients. Low $ETCO_2$ levels were the strongest predictor of mortality in the overall group (area under the receiver operating characteristic curve (AUC of 0.76, 95% confidence interval [CI] 0.66-0.85), as well as subgroup analysis excluding prehospital cardiac arrest (AUC of 0.77, 95% CI 0.67-0.87). The sensitivity of abnormal $ETCO_2$ for predicting mortality was 93% (95% CI 79%-98%), the specificity was 44% (95% CI 41%-48%), and the negative predictive value was 99% (95% CI 92%-100%). There were significant associations between $ETCO_2$ and serum bicarbonate levels ($r = 0.429$, $P < .001$), anion gap ($r = -0.216$, $P < .001$), and lactate ($r = -0.376$, $P < .001$).

Conclusion: Of all prehospital vital signs, $ETCO_2$ was the most predictive and consistent for mortality, which may be related to an association with metabolic acidosis.

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, respirations and pulse oximetry. Exhaled end-tidal carbon dioxide ($ETCO_2$) can be measured non-invasively by capnography and may provide further information regarding physiologic function.

$ETCO_2$ 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 $ETCO_2$ 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 $ETCO_2$ 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 $ETCO_2$ measurement as an outcome predictor compared to conventional vital signs in an undifferentiated sample of patients. We hypothesize that abnormal $ETCO_2$ 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.

* Corresponding author. Orange County EMS, Orlando, FL 32806, USA. Tel.: +1 407 836 6513; fax: +1 407 836 7625.
E-mail address: christopher.hunter@ocfl.net (C.L. Hunter).

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Basic
Advanced

Annals of Internal Medicine ORIGINAL RESEARCH

Outcomes of Basic Versus Advanced Life Support for Out-of-Hospital Medical Emergencies

Prachi Sanghavi, PhD; Anupam B. Jena, MD, PhD; Joseph P. Newhouse, PhD; and Alan M. Zaslavsky, PhD

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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For author affiliations, see end of text.

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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 existing evidence does not support its value. Prior studies

trauma until there is greater evidence of its benefits (17, 18).

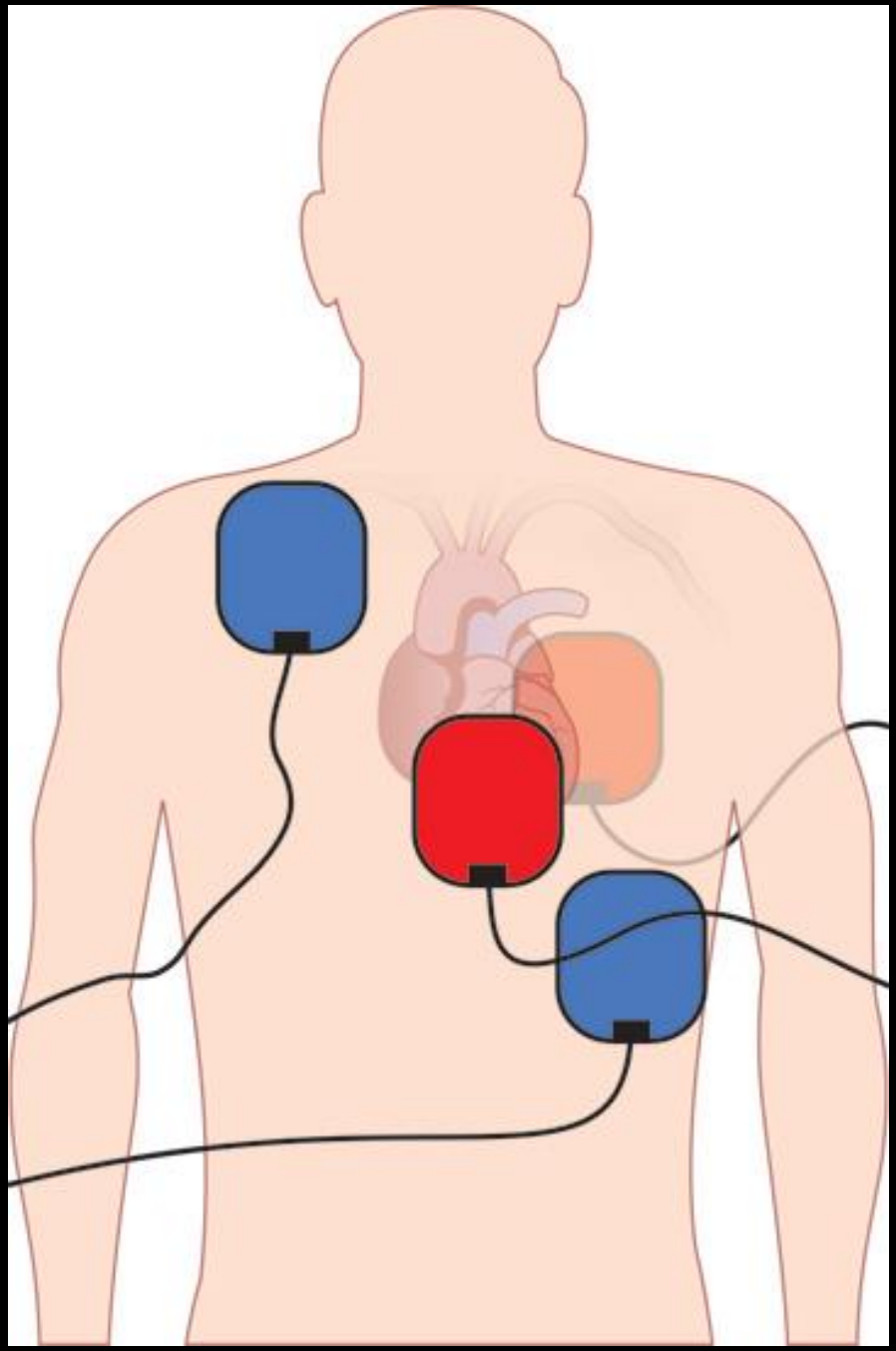
Because a randomized trial comparing ALS with BLS is unlikely, we conducted a large-scale observational study to compare survival and neurologic outcomes between Medicare beneficiaries with major trauma, stroke, acute myocardial infarction (AMI), or respiratory failure who received ALS versus BLS prehospital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



RESUSCITATION
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European Resuscitation Council

Article in Press

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

Eric Cortez, William Krebs, James Davis, David P. Keseg, Ashish R. Panchal

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 (refractory 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 outcome 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 17 years of age. The outcomes we evaluated were the number of patients with return of spontaneous circulation, conversion from VF, survival-to-hospital discharge, and Cerebral Performance Category score.

Results

Total of 2428 OHCA events were reviewed with twelve patients treated with DSD. Median DSD and prehospital resuscitation times were 27 min (IQR 22–33) and 32 (IQR 24–38), respectively. Of the 12 patients treated

PRELIMINARY REPORT

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

José G. Cabañas, MD, MPH, J. Brent Myers, MD, MPH, Jefferson G. Williams, MD, MPH, Valerie J. De Maio, MD, MSc, Michael W Bachman, MHS, EMT-P

ABSTRACT

Background. Ventricular fibrillation (VF) is considered the out-of-hospital cardiac arrest (OOHCA) rhythm with the highest likelihood of neurologically intact survival. Unfortunately, there are occasions when VF does not respond to standard defibrillatory shocks. Current American Heart Association (AHA) guidelines acknowledge that the data are insufficient in determining the optimal pad placement, waveform, or energy level that produce the best conversion rates from OOHCA with VF. **Objective.** To describe a technique of double sequential external defibrillation (DSED) for cases of refractory VF (RVF) during OOHCA resuscitation. **Methods.** A retrospective case series was performed in an urban/suburban emergency medical services (EMS) system with advanced life support care and a population of 900,000. Included were all adult OOHCAs having RVF during resuscitation efforts by EMS providers. RVF was defined as persistent VF following at least 3 unsuccessful single shocks, epinephrine administration, and a dose of antiarrhythmic medication. Once the patient was in RVF, EMS personnel applied a second set of pads and utilized a second defibrillator for single defibrillation with the new monitor/pad placement. If VF continued, EMS personnel then utilized the original and second monitor/defibrillator changed to maximum energy, and shocks were delivered from both machines simultaneously. Data were collected from electronic dispatch and patient care reports for descriptive analysis. **Results.** From 01/07/2008 to 12/31/2010, a total of 10 patients were treated with DSED. The median age was 76.5 (IQR: 65–82), with median resuscitation time of 35 minutes (IQR: 45–62). The median number of single shocks was 6.5 (IQR: 6–11), with a median of 2 (IQR: 1–3) DSED shocks delivered. VF broke after DSED in 7 cases (70%). Only 3 patients (30%) had ROSC in the field, and none survived to discharge. **Conclusion.** This case series demonstrates that DSED may be a feasible technique as part of an aggressive treatment plan for RVF in the out-of-hospital setting. In this series, RVF was terminated 70% of the time, but no patient survived to discharge. Further research is needed to better understand the characteristics of and treatment strategies for RVF.

Key words: double sequential; defibrillation; out-of-hospital; cardiac arrest; ventricular fibrillation

PREHOSPITAL EMERGENCY CARE 2015;19:126–130

INTRODUCTION

Out-of-hospital cardiac arrest (OOHCA) remains a common cause of death in the United States, with an estimated 424,000 incidents every year and an overall survival of 10.4%.[1] Ventricular fibrillation (VF) is considered the OOHCA rhythm with the highest likelihood of neurologically intact survival.[2–4] Current out-of-hospital treatment strategies focus on early defibrillation and effective quality chest compressions with minimal interruptions.[5] External defibrillation remains the primary treatment for VF.[6,7] Unfortunately, there are occasions when VF does not respond to current out-of-hospital treatment strategies, including standard defibrillatory shocks.

Refractory VF (RVF) is considered a rare clinical event with an estimated incidence of 0.5–0.6 per 100,000 population.[8] The actual number of events of

Received January 31, 2014 from the Wake County EMS System, Raleigh, North Carolina (JGC, JBM, JGW, MWB), Austin-Travis County EMS System, Austin, Texas (EJ.C), and Emergency Services Institute, Clinical Research Unit, Wakefield Health & Hospitals, Raleigh, North Carolina (JBM, JGW, VJDi). Revision received June 8, 2014; accepted for publication June 16, 2014.

Presented at the National Association Physicians annual meeting in 2013, Bonita Springs, Florida.

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

The authors thank Brian Lester, Ryan Lewis, and Joseph Zelken for their valuable contributions. We also want to acknowledge the emergency medical dispatchers, firefighter first responders, and BLS, and ALS members of the Wake EMS System for the commitment to provide prompt, compassionate, clinically excellent care.

Address correspondence to Jose G. Cabanas, MD, MPH, Deputy Medical Director, Office of the Medical Director, Austin/Travis County EMS System, 727 S Pleasant Valley Road, Austin, Texas 78741, USA. E-mail: jgcabanas@me.com

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Clinical study

Double sequential external shocks for refractory ventricular fibrillation

David H. Hoch, MD, PhD, FACC [a], William P. Batsford, MD [*], Steven M. Greenberg, MD, FACC [a], Craig M. McPherson, MD, FACC [*], Lynda E. Rosenfeld, MD, FACC [*], Mark Marieb, MD [*], Joseph H. Levine, MD, FACC [a]

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doi:10.1016/0735-1097(94)90602-5

Abstract

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

Background. Refractory ventricular fibrillation can occur in up to 0.1% of electrophysiologic 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 electrophysiologic 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.

RESUSCITATION

OFFICIAL JOURNAL OF THE EUROPEAN RESUSCITATION COUNCIL

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Article in Press

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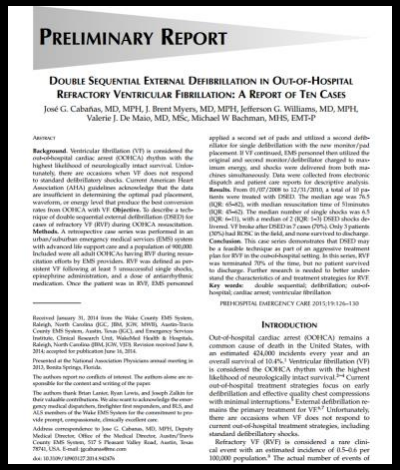

PRELIMINARY REPORT

Double Sequential External Defibrillation in Out-of-Hospital Refractory Ventricular Fibrillation: A Report of Ten Cases

José G. Cabañas, MD, MPH, J. Brent Myers, MD, MPH, Jefferson G. Williams, MD, MPH, Valerie J. De Maio, MD, MSc, Michael W Bachman, MHS, EMT-P

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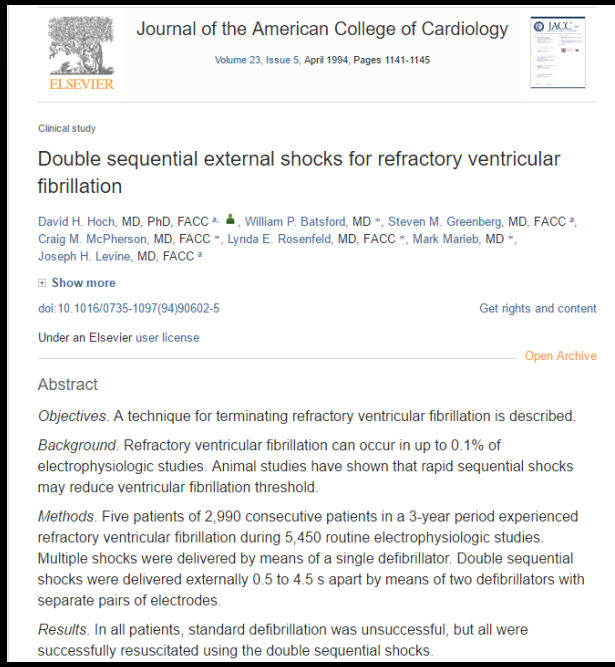

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Clinical study

Double sequential external shocks for refractory ventricular fibrillation

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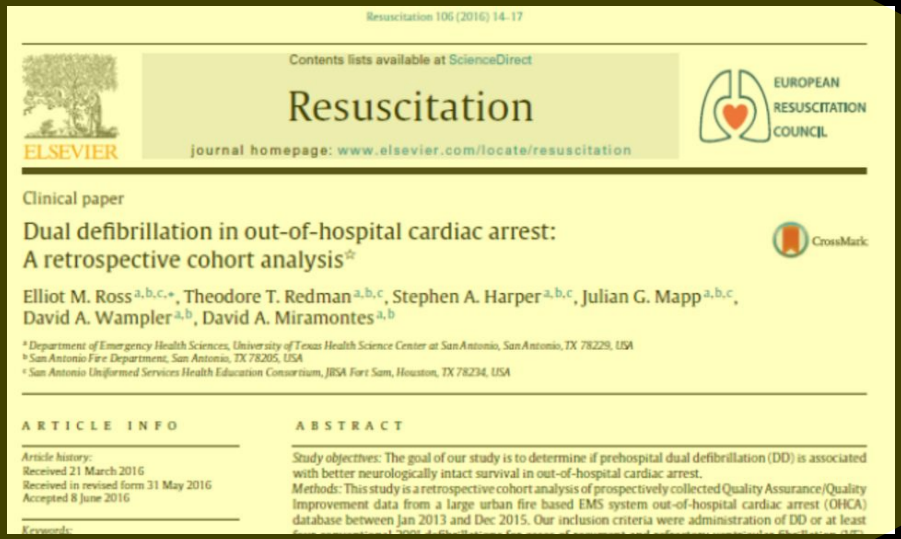

Resuscitation 106 (2016) 14–17

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journal homepage: www.elsevier.com/locate/resuscitation

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EUROPEAN RESUSCITATION COUNCIL

Clinical paper

Dual defibrillation in out-of-hospital cardiac arrest: A retrospective cohort analysis☆

CrossMark

Elliot M. Ross [a,b,c,*], Theodore T. Redman [a,b,c], Stephen A. Harper [a,b,c], Julian G. Mapp [a,b,c], David A. Wampler [a,b], David A. Miramontes [a,b]

[a] Department of Emergency Health Sciences, University of Texas Health Science Center at San Antonio, San Antonio, TX 78229, USA
[b] San Antonio Fire Department, San Antonio, TX 78205, USA
[c] San Antonio Uniformed Services Health Education Consortium, JBSA Fort Sam, Houston, TX 78234, USA

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ABSTRACT

Study objectives: The goal of our study is to determine if prehospital dual defibrillation (DD) is associated with better neurologically intact survival in out-of-hospital cardiac arrest.
Methods: This study is a retrospective cohort analysis of prospectively collected Quality Assurance/Quality Improvement data from a large urban fire based EMS system out-of-hospital cardiac arrest (OHCA) database between Jan 2013 and Dec 2015. Our inclusion criteria were administration of DD or at least

Sepsis

BRIEF REPORT

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

Amado Alejandro Baez, MD;[1] Priscilla Hanudel, MD;[2] Susan Renee Wilcox, MD[3]

1. Los Centros de Diagnóstico y Medicina Avanzada y de Conferencias Médicas y Telemedicina (CEDIMAT), Emergency Medicine/Critical Care, Santo Domingo, Dominican Republic and University of Miami, Division of Emergency Medicine, Miami, Florida USA
2. University of California, Los Angeles (UCLA), Emergency Medicine, Los Angeles, California USA
3. Massachusetts General Hospital and Harvard Medical School, Emergency Medicine, Boston, Massachusetts USA

Correspondence:
Susan Renee Wilcox, MD
Massachusetts General Hospital
Department of Emergency Medicine
Department of Anesthesia, Critical Care and Pain Medicine
Zero Emerson Place, #3b
Boston, MA 02114 USA
E-mail: swilcox1@partners.org

Conflicts of interest: none

Keywords: predictors; prehospital; sepsis

Abbreviations:
ED: emergency department
EGDT: early goal-directed therapy
EMS: Emergency Medical Services
EMT: emergency medical technician
HLOS: hospital length of stay
HR: heart rate
ICU: intensive care unit
ICU-LOS: intensive care unit length-of-stay
MAP: mean arterial pressure
PSP: Prehospital Sepsis Project
RR: respiratory rate
SBP: systolic blood pressures
SI: shock index
SIRS: systemic inflammatory response syndrome

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Revised: July 23, 2013
Accepted: July 25, 2013

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 ratio (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 out 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: $P = .39$; HR >90: $P = .60$; RR >20 $P = .11$; 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.

Baez AA, Hanudel P, Wilcox SR. The prehospital sepsis project: out-of-hospital physiologic predictors of sepsis outcomes. *Prehosp Disaster Med.* 2013;28(6):632-635.

Introduction

Severe sepsis and septic shock are common and expensive medical problems. With an estimated incidence of 751,000 cases (3.0 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.[1-4] 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,[2] making sepsis care a critical issue.

The initial component of the sepsis continuum is the systemic inflammatory response syndrome (SIRS). As a proinflammatory state, SIRS is associated with clinical findings that include tachycardia, tachypnea, alterations in white cell count, and thermal dysregulation.[4,5] 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.[5,6]

The mortality rate of severe sepsis and septic shock is significantly higher than other states of recognized time-sensitive critical illness, such as myocardial infarction or

Association of Fluid Resuscitation Initiation Within 30 Minutes of Severe Sepsis and Septic Shock Recognition With Reduced Mortality and Length of Stay

Daniel Leisman, BS*; Benjamin Wie, BA; Martin Doerfler, MD; Andrea Bianculli, BA; Mary Frances Ward, RN, MS; Meredith Akerman, MS; John K. D'Angelo, MD; Jason A. Zemmel D'Amore, MD

*Corresponding Author. E-mail: deleisman@gmail.com.

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 (90,000 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 1,866 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-six percent of subjects were administered intravenous antibiotics within 180 minutes; 1,193 (64%) 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 8.5%), 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 16.0% (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 initiation: 6 days (95% CI 6 to 7 days) versus 7 days (95% CI 6 to 7 days) versus 7 days (95% CI 6 to 8 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 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.

0196-0644/$-see front matter

http://dx.doi.org/10.1016/j.annemergmed.2016.02.044

SEE EDITORIAL, P. 312.

INTRODUCTION

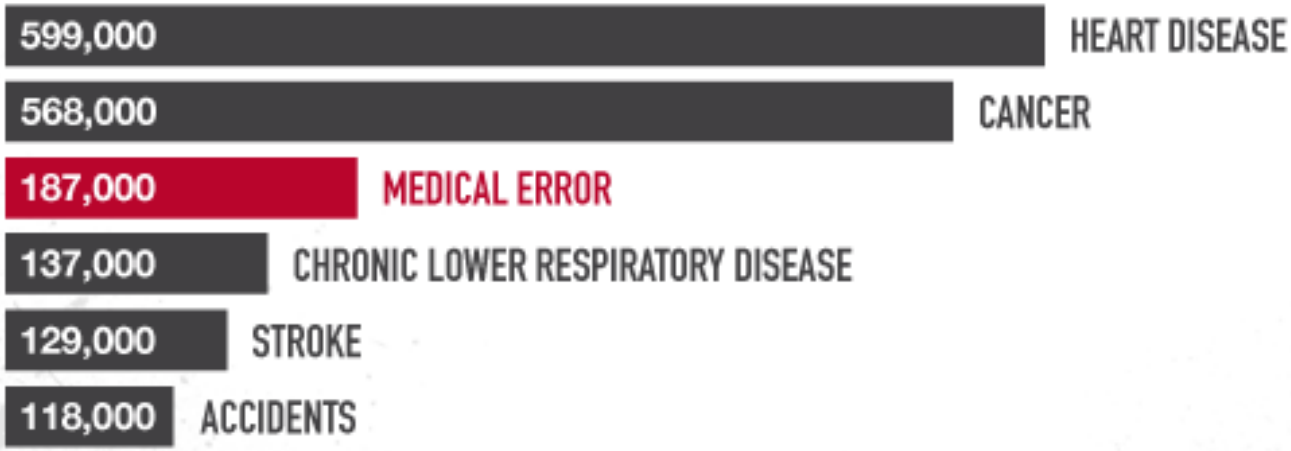
Background

Sepsis, severe sepsis, and septic shock are principal drivers of morbidity and mortality worldwide.[1-4] The seminal trial by Rivers et al[5] in 2001 espoused the efficacy of early goal-directed therapy protocols, but 3 recent, multisite, randomized trials failed to demonstrate mortality benefit from such therapy compared with usual care.[6-8] However, in all 3 trials, all patients in both study and control arms received early intravenous fluid resuscitation and intravenous antibiotic administration.

Early intervention is critical in managing severe sepsis and septic shock. Current guidelines from the National Quality Forum and Surviving Sepsis Campaign recommend administration of crystalloid at 30 mL/kg and intravenous broad-spectrum antibiotics within 3 hours of a patient's first meeting severe sepsis or septic shock criteria.[9,10] After the 2006 article by Kumar et al[11]

MEDICAL ERROR

would be the 3rd leading killer in the U.S. per year



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November 1999

INSTITUTE OF MEDICINE

Shaping the Future for Health

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.

Errors…are costly in terms of loss of trust in the health care system by patients and diminished satisfaction by both patients and health professionals.

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

Gary M. Vilke, MD, Stephen V. Tornabene, BA, Barbara Stepanski, MPH, Holly E. Shipp, MPH, Leslie Upledger Ray, MA, MPPA, Marcelyn A. Metz, RN, Dori Vroman, RN, Marilyn Anderson, RN, Patricia A. Murrin, RN, MPH, Daniel P. Davis, MD, Jim Harley, MD

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 a mean 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 (63%), protocol errors (33%), wrong route errors (21%), and wrong medication errors (4%). Issues identified in contributing to the errors include failure to triple check, infrequent 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 (79.1%), with 8.3% being reported by the base hospital radio nurse, 8.3% 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.

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Abstract presented as a poster presentation at the NAEMSP Annual Conference, Naples, Florida, January 2005.

Barbara Stepanski, Holly E. Shipp, Leslie Upledger Ray, Marcelyn A. Metz, Dori Vroman, Marilyn Anderson, and Patricia A. Murrin were involved in collection and distribution of the surveys as well as the design of the survey tool.

Dr. Vilke, Dr. Davis, Dr. Harley, and Stephen Tornabene were involved in study design, data analysis, and manuscript preparation.

Address correspondence to: Gary M. Vilke, MD, Department of Emergency Medicine, UC San Diego Medical Center, 200 West Arbor Drive Mailcode #8676, San Diego, CA 92103. e-mail: <gmvilke@ucsd.edu>.

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Introduction

The landmark 1999 Institute of Medicine report *To Err is Human: Building a Safer Health System*[1] 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" highlighted the gravity of this problem.

Following this report many hospitals introduced new safeguards to protect patients from these errors[2]. 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 "19% or 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

P. Daniel Patterson, PhD, EMT-B, Matthew D. Weaver, MPH, NREMT-P, Rachel C. Frank, EMT-B, Charles W. Warner, NREMT-P, Christian Martin-Gill, MD, MPH, Francis X. Guyette, MD, MPH, Rollin J. Fairbanks, MD, MS, Michael W. Hubble, PhD, MBA, NREMT-P, Thomas J. Songer, PhD, Clifton W. Callaway, MD, PhD, Sheryl F. Kelsey, PhD, David Hostler, PhD, CSCS

Abstract

Objective. To determine the association between poor sleep quality, fatigue, and self-reported safety outcomes among emergency medical services (EMS) workers. **Methods.** We used convenience sampling of EMS agencies and a cross-sectional survey design. We administered the 19-item Pittsburgh Sleep Quality Index (PSQI), 11-item Chalder Fatigue Questionnaire (CFQ), and 44-item EMS Safety Inventory (EMS-SI) to measure sleep quality, fatigue, and safety outcomes, respectively. We used a consensus process to develop the EMS-SI, which was designed to capture three composite measurements of EMS worker injury, medical errors and adverse events (AEs), and safety-compromising behaviors. We used hierarchical logistic regression to test the association between poor sleep quality, fatigue, and three composite measures of EMS worker safety outcomes. **Results.** We received 547 surveys from 30 EMS agencies (a 35.6% mean agency response rate). The mean PSQI score exceeded the benchmark for poor sleep (6.9, 95% confidence interval [CI] 6.6, 7.2). More than half of the respondents were classified as fatigued (55%, 95% CI 50.7, 59.3). Eighteen percent of the respondents reported an injury (17.8%, 95% CI 13.5, 22.1), 41% reported a medical error or AE (41.1%, 95% CI 36.8, 45.4), and 90% reported a safety-compromising behavior (89.6%, 95% CI 87, 92). After controlling for confounding, we identified 1.9 greater odds of injury (95% CI 1.1, 3.3), 2.2 greater odds of medical error or AE (95% CI 1.4, 3.3), and 3.6 greater odds of safety-compromising behavior (95% CI 1.5, 8.3) among fatigued respondents versus nonfatigued respondents. **Conclusions.** In this sample of EMS workers, poor sleep quality and fatigue are common. We provide preliminary evidence of an association between sleep quality, fatigue, and safety outcomes. **Key words:** sleep; fatigue; safety; injury; errors; occupational accidents

Prehospital Emergency Care 2012;16:86–97

Introduction

Poor sleep quality and fatigue among health care workers contribute to poor safety outcomes such as error and injury.[1] Annually, medical errors and adverse events (AEs) affect hundreds of thousands of patients and contribute to as much as $28 billion in additional health care costs.[2] The World Health Organization (WHO) identified fatigue as a leading factor in medical error and injury in health care.[3] The Accreditation Council for Graduate Medical Education (ACGME) has twice recommended reductions in work time for medical trainees due in part to concerns about fatigue.[4] Little is known about the linkage between fatigue, sleep, and safety in emergency medical services (EMS), a high-risk environment for patients and providers.

The risk of negative outcomes for the EMS worker and patient is high and different from risks from within the hospital. For example, the EMS worker makes a decision to provide medication or other treatment within minutes or even seconds of establishing a general impression of patient and condition. These decisions are made in a fast-paced and uncertain environment where the patient and bystanders can be violent, create distractions, or disrupt care delivery. Decisions are based on written protocols and radio-enabled assistance from a medical oversight physician. Care may be delivered with some assistance from a single partner, an emergency medical technician (EMT) or paramedic.

Received April 28, 2011, from the Department of Emergency Medicine, University of Pittsburgh (PDP, MDW, RCF, CWW, CM-G, FXG, CWC, DH) Pittsburgh, Pennsylvania; the Department of Epidemiology, University of Pittsburgh Graduate School of Public Health (TJS, SFK), Pittsburgh, Pennsylvania; the National Center for Human Factors Engineering in Healthcare (RJF), Washington, DC; and the Department of Health Sciences, Western Carolina University (MDW), Cullowhee, North Carolina. Revision received July 3, 2011; accepted for publication July 25, 2011.

This research was presented at the National Association of EMS Physician's Annual Meeting, Bonita Springs, FL, 2011.

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Address correspondence and reprint requests to: Daniel Patterson, PhD, University of Pittsburgh, Emergency Medicine, 3600 Forbes Ave, Suite 400A, Pittsburgh, PA, 15261. E-mail: pattersond@upmc.edu

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The Shift Length, Fatigue, and Safety Conundrum in EMS

P. Daniel Patterson, PhD, Matthew D. Weaver, MPH, NREMT-P, David Hostler, PhD, Francis X. Guyette, MD, MPH, Clifton W. Callaway, MD, PhD, Donald M. Yealy, MD

Shift length and fatigue among emergency medical services (EMS) providers may increase error and injury.[1–3] Shift work is inevitable 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 transitioning to 1500–2300) really superior to a 24-hours-on, 48-hours-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 in EMS view these questions from different perspectives. Some point to longer shifts as necessary to achieve lower operating costs related to staffing, a compressed workweek, and the flexibility to have more time with family or on a second job. Others may presume that longer shifts can lead to poor care or poor provider health. There is limited support for or against the 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 towards 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 fire-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.[4,5] 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.[4] 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 posits a mediation model,[6] 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 daylight hours (7/8 AM–5/6 PM)."[7] Definitions and descriptions of shift work vary by service sector, duration of shift, method of rotation, duration of rotation, regularity/irregularity, and number of rest/work days.[7] 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 both within and outside the public safety sector.[4] All of this complicates the definitions and assessments of impact.

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Address correspondence and reprint requests to: P. Daniel Patterson, PhD, University of Pittsburgh, Emergency Medicine, 3600 Forbes Avenue, Iroquois Building, Suite 400A, Pittsburgh, PA 15260. e-mail: pattersond@upmc.edu

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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.[1,2] Poor sleep, which is a precursor to short term or chronic fatigue, affects between 29% and 35% of U.S. adults.[3,4] Fatigue affects one in every four U.S. workers (38%; 95%CI 37.4, 38.5).[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.[6-9] Furthermore, research has identified a strong association between poor sleep, fatigue, poor safety outcomes, and risks to long-term health.[1,2,10-12]

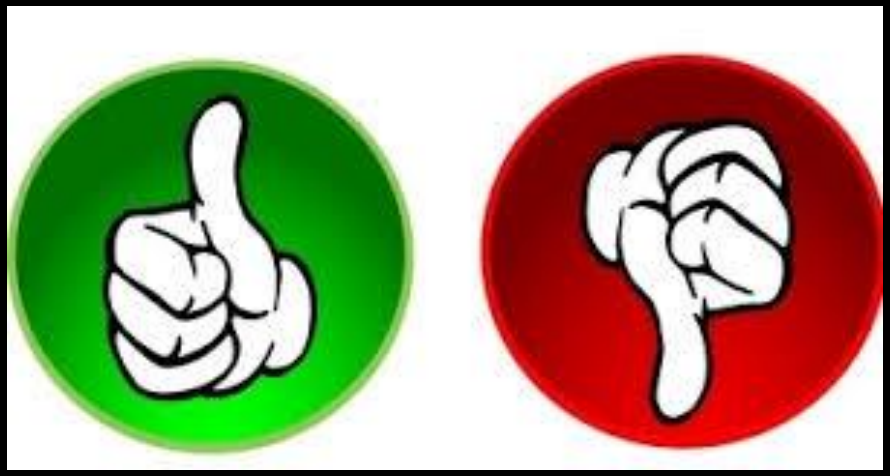
There is limited research that examines fatigue and poor sleep among EMS providers.[1,2,13-17] However, there is widespread concern that EMS providers and patients are at an increased risk of poor safety outcomes related to fatigue.[15,16] Factors believed to increase this risk include the atypical work schedule (shift work),[16,18,19] providers holding multiple jobs[2] with risks of chronic fatigue syndromes,[20] unpredictable nature of EMS call volume which affects ability to rest,[21,22] increased need and demand for EMS responses tied to increased productivity requirements limiting opportunities for rest ,[23] a high prevalence of poor sleep and fatigue among EMS workers,[1,2] a high prevalence of occupational stress and burnout,[22,24-27] poor health status among EMS workers,[28,29] high risk of occupational injury and mortality,[30-35] and wide variation in workplace safety culture.[36,37]

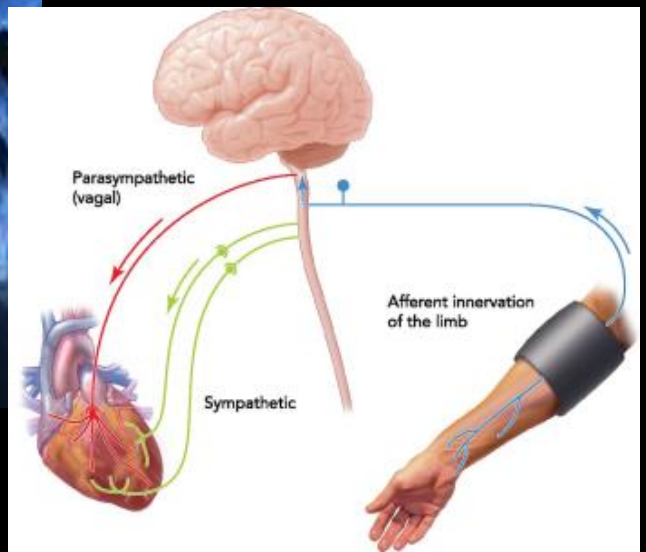
EMS is a vital public health resource, providing care for more than 30 million ill and injured patients annually.[38] Poor sleep and fatigue among EMS workers represent potential threats to patient care, provider wellbeing, and the public's health and trust in EMS.[16]

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 combatting the impact of fatigue on EMS patient and provider safety.




Parasympathetic
(vagal)
Afferent innervation
of the limb
Sympathetic

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THE PRESENT AND FUTURE

STATE-OF-THE-ART REVIEW

Remote Ischemic Conditioning

Gerd Heusch, MD,* Hans Erik Bøtker, MD, PhD,† Karin Przyklenk, PhD,‡ Andrew Redington, MD,§ Derek Yellon, PhD, DSc‖

ABSTRACT

In 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-144, 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).

From the *Institute for Pathophysiology, West German Heart and Vascular Centre Essen, University of Essen Medical School, Essen, Germany; †Department of Cardiology, Aarhus University Hospital Skejby, Aarhus, Denmark; ‡Cardiovascular Research Institute, Wayne State University School of Medicine, Detroit, Michigan; §Hospital for Sick Children and University of Toronto, Toronto, Ontario, Canada; and ‖The Hatter Cardiovascular Institute, University College London, London, United Kingdom. Dr. Heusch serves as a consultant to Servier; and is supported by the German Research Foundation (He 1320/18-1, 3). Dr. Bøtker has

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

Hans Erik Bøtker, Rajesh Kharbanda, Michael R Schmidt, Morten Bøttcher, Anne K Kaltoft, Christian J Terkelsen, Kim Munk, Niels H Andersen, Troels M Hansen, Sven Trautner, Jens Flensted Lassen, Evald Høj Christiansen, Lars R Krusell, Steen D Kristensen, Leif Thuesen, Søren S Nielsen, Michael Rehling, Henrik Toft Sørensen, Andrew N Redington, Torsten T Nielsen

Summary

Background Remote ischaemic preconditioning attenuates cardiac injury at elective surgery and angioplasty. We tested the hypothesis that remote ischaemic conditioning during evolving ST-elevation myocardial infarction, and done before primary percutaneous coronary intervention, increases myocardial salvage.

Methods 333 consecutive adult patients with a suspected first acute myocardial infarction were randomly assigned in a 1:1 ratio by computerised block randomisation to receive primary percutaneous coronary intervention with (n=166 patients) versus without (n=167) remote conditioning (intermittent arm ischaemia 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 NCT00435266.

Findings 82 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 0·75 (IQR 0·50–0·93, n=73) in the remote conditioning group versus 0·55 (0·35–0·88, n=69) in the control group, with median difference of 0·10 (95% CI 0·01–0·22; p=0·0333); mean salvage index was 0·69 (SD 0·27) versus 0·57 (0·26), with mean difference of 0·12 (95% CI 0·01–0·21; p=0·0333). Major adverse coronary events were death (n=3 per group), reinfarction (n=1 per group), and heart failure (n=3 per group).

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

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Lancet 2010; 375: 727–34

See Comment page 699

Department of Cardiology (Prof H E Bøtker MD, M R Schmidt MD, M Bøttcher MD, A K Kaltoft MD, C J Terkelsen MD, K Munk MD, N H Andersen MD, J F Lassen MD, E H Christiansen MD, L R Krusell MD, S D Kristensen MD, L Thuesen MD, Prof T T Nielsen MD), **Department of Nuclear Medicine** (S S Nielsen MD, M Rehling MD), and **Department of Clinical Epidemiology** (Prof H T Sørensen MD), **Aarhus University Hospital Skejby, Aarhus N, Denmark; Department of Cardiovascular Medicine, West Wing, John Radcliffe Hospital, Headington, Oxford, UK** (R Kharbanda MD); **Mobile Emergency Care Unit, Department of Anaesthesiology, Aarhus University Hospital Aarhus, Aarhus C, Denmark** (T M Hansen MD); **Falck Ambulance Service, The Falck House, Copenhagen, Denmark** (S Trautner MD); **and Division of Cardiology, Hospital for Sick Children, University of Toronto, Toronto, ON, Canada** (Prof A N Redington MD)

Correspondence to:
Prof Hans Erik Bøtker, Department of Cardiology, Aarhus University Hospital Skejby, DK-8200 Aarhus N, Denmark
heb@dadlnet.dk

Introduction

ST-elevation myocardial infarction is a leading cause of mortality and morbidity. Infarct size is an important determinant of outcome. Hence reduction 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.[3–5]

An alternative approach for treatment is to exploit innate cytoprotective mechanisms. Findings from recent studies of local postconditioning and targeting of mitochondrial pathways in myocardial infarction have indicated success in reduction of infarct size in patients with occluded left anterior descendent artery.[6,7] Remote ischaemic preconditioning, induced by repeated brief periods of limb ischaemia before index ischaemia,[8] reduces myocardial injury in patients exposed to predictable ischaemia.[9–12] Furthermore, remote ischaemic postconditioning, applied in the early reperfusion phase after prolonged ischaemia, seems to be more effective than local postconditioning in experimental myocardial infarction.[12] We have shown that conditioning, by intermittent limb ischaemia after the onset of myocardial ischaemia and before reperfusion, reduces infarct size in a porcine model.[13] 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,[14] in patients with a first acute and evolving myocardial infarction.

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FASTTRACK CLINICAL RESEARCH

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[1]*, Michael R. Schmidt[1], Kim Munk[1], Rajesh K. Kharbanda[2], Andrew N. Redington[3], Morten Schmidt[4], Lars Pedersen[4], Henrik T. Sørensen[4], and Hans Erik Bøtker[1], CONDI Investigators

[1]Department of Cardiology, Aarhus University Hospital, Aarhus N, Denmark; [2]Oxford University Hospitals, John Radcliffe Hospital, Oxford, UK; [3]Division of Cardiology, Hospital for Sick Children, Toronto, Canada; and [4]Department of Clinical Epidemiology, Aarhus University Hospital, Aarhus N, Denmark

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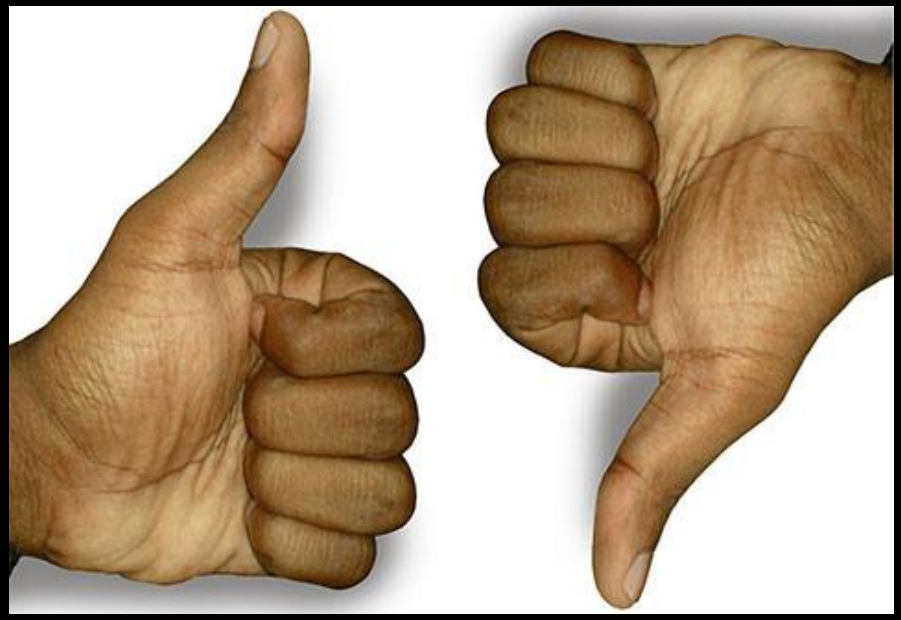
See page 138 for the editorial comment on this article (doi:10.1093/eurheartj/eht478)

Aims Remote ischaemic conditioning as an adjunct to primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction increases myocardial salvage. We investigated the effect of remote ischaemic conditioning on long-term clinical outcome.

Methods and results From February 2007 to November 2008, 333 patients with a suspected first acute ST-elevation myocardial infarction were randomized to receive primary percutaneous coronary intervention with (*n* = 166) or without (*n* = 167) remote ischaemic conditioning (intermittent arm ischaemia through four cycles of 5-min inflation followed by 5-min deflation of a blood-pressure cuff). Patient follow-up extended from the randomization date until last outcome, emigration or January 2012 (median follow-up = 3.8 years). The primary endpoint was major adverse cardiac and cerebrovascular events (MACCE)—a composite of all-cause mortality, myocardial infarction, readmission for heart failure, and ischaemic stroke/transient ischaemic attack. The individual components of the primary endpoint comprised the secondary end-



Prehospital Neuroprotective Therapy for Acute Stroke

Results of the Field Administration of Stroke Therapy–Magnesium (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 ≤ 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.[1–6] The Field Administration of Stroke Therapy–Magnesium (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 ≥ 15 minutes and ≤ 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.[7–9] 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 (Abboject; Abbott Laboratories) by slow intravenous push over 10 minutes. Emergency department staff administered the remainder of

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From Stroke Center (J.L.S., C.K., S.S.), Department of Neurology (J.L.S., C.K., S.S.), and Department of Emergency Medicine (S.S.), Geffen School of Medicine of the University of California, Los Angeles; and Department of Emergency Medicine (M.E.), Keck School of Medicine of the University of Southern California and Los Angeles Fire Department.

Correspondence to Dr Jeffrey L. Saver, UCLA Stroke Center, 710 Westwood Plaza, Los Angeles, CA 90095. E-mail jsaver@ucla.edu

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TRAUMA


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Prehospital Cervical Spinal Immobilization After Trauma

Nicholas Theodore, MD*
Mark N. Hadley, MD†
Bizhan Aarabi, MD, FRCSC¶
Sanjay S. Dhall, MD‖
Daniel E. Gelb, MD#
R. John Hurlbert, MD, PhD, FRCSC**
Curtis J. Rozzelle, MD††
Timothy C. Ryken, MD, MS§§
Beverly C. Walters, MD, MSc, FRCSC‖¶

*Division of Neurological Surgery, Barrow Neurological Institute, Phoenix, Arizona; †Division of Neurological Surgery; and ††Division of Neurological Surgery, Children's Hospital of Alabama, University of Alabama at Birmingham, Birmingham, Alabama; §Department of Neurosciences, Inova Health System, Falls Church, Virginia; ¶Department of Neurosurgery and; #Department of Orthopaedics, University of Maryland, Baltimore, Maryland; ‖Department of Neurosurgery, Emory University, Atlanta, Georgia; **Department of Clinical Neurosciences, University of Calgary Spine Program, Faculty of Medicine, University of Calgary, Calgary, Alberta, Canada; §§Iowa Spine & Brain Institute, University of Iowa, Waterloo/ Iowa City, Iowa

Correspondence:
Mark N. Hadley, MD, FACS, UAB Division of Neurological Surgery, 510 – 20th St S, FOT 1030, Birmingham, AL 35294-3410.
E-mail: mhadley@uabmc.edu

KEY WORDS: EMS clinical protocol, Potential spinal injury, Rigid cervical collar, Spinal immobilization

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RECOMMENDATIONS

Level II

Spinal immobilization of all trauma patients with a cervical spine or spinal cord injury or with a mechanism of injury having the potential to cause cervical spinal injury is recommended.

- Triage of patients with potential spinal injury at the scene by trained and experienced emergency medical services personnel to determine the need for immobilization during transport is recommended.
- Immobilization of trauma patients who are awake, alert, and are not intoxicated; who are without neck pain or tenderness; who do not have an abnormal motor or sensory examination; and who do not have any significant associated injury that might detract from their general evaluation is not recommended.

Level III

- A combination of a rigid cervical collar and supportive blocks on a backboard with straps is effective in limiting motion of the cervical spine and is recommended.
- The longstanding practice of attempted spinal immobilization with sandbags and tape is insufficient and is not recommended.
- Spinal immobilization in patients with penetrating trauma is not recommended because of increased mortality from delayed resuscitation.

ABBREVIATIONS: EMS, emergency medical services; **HAINES,** high arm in endangered spine; **ICP,** intracranial pressure

RATIONALE

The early management of a patient with a potential cervical spinal cord injury begins at the scene of the accident. The chief concern during the initial management of patients with potential cervical spinal injuries is that neurologic function may be impaired as a result of pathologic motion of the injured vertebrae. It is estimated that 3% to 25% of spinal cord injuries occur after the initial traumatic insult, either during transit or early in the course of management.[1-4] Multiple cases of poor outcome from mishandling of cervical spinal injuries have been reported.[5-8] As many as 20% of spinal column injuries involve multiple noncontinuous vertebral levels; therefore, the entire spinal column is potentially at risk.[9-12] Consequently, complete spinal immobilization has been used in prehospital spinal care to limit motion until injury has been ruled out.[11-19] Over the last 30 years, there has been a dramatic improvement in the neurologic status of spinal cord–injured patients arriving in emergency departments. During the 1970s, the majority (55%) of patients referred to regional spinal cord injury centers arrived with complete neurological lesions. In the 1980s, however, the majority (61%) of spinal cord-injured patients arrived with incomplete lesions.[20] This improvement in the neurologic status of patients has been attributed to the development of emergency medical services (EMS) in 1971 and the prehospital care (including spinal immobilization) rendered by EMS personnel.[13,20-22] Spinal immobilization is now an integral part of prehospital management and is advocated for all patients with potential spinal injury after trauma by EMS programs nationwide and by the American College of Surgeons.[15,23-25]

Recently, the use of spinal immobilization particularly for those patients with a low

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Review

Prehospital Use of Cervical Collars in Trauma Patients: A Critical Review

Terje Sundstrøm,[1–3] Helge Asbjørnsen,[4,5] Samer Habiba,[3] Geir Arne Sunde,[6–8] and Knut Wester[2,3]

Abstract

The cervical collar has been routinely used for trauma patients for more than 30 years and is a hallmark of state-of-the-art prehospital trauma care. However, the existing evidence for this practice is limited: Randomized, controlled trials are largely missing, and there are uncertain effects on mortality, neurological injury, and spinal stability. Even more concerning, there is a growing body of evidence and opinion against the use of collars. It has been argued that collars cause more harm than good, and that we should simply stop using them. In this critical review, we discuss the pros and cons of collar use in trauma patients and reflect on how we can move our clinical practice forward. Conclusively, we propose a safe, effective strategy for prehospital spinal immobilization that does not include routine use of collars.

Key words: cervical collar; cervical injury; cervical spine; prehospital; trauma

Introduction

Cervical collars are considered important measures in modern prehospital trauma care. The recommended practice of routine application of collars in trauma patients has largely been unchanged for more than 30 years.[1] It is featured as a prioritized procedure in the Advanced Trauma Life Support (ATLS) guidelines from the American College of Surgeons (ACS)[2] and the Prehospital Trauma Life Support (PHTLS) guidelines from the National Association of Emergency Medical Technicians (NAEMT).[3] These guidelines dominate the field of prehospital trauma care, and ATLS and PHTLS are implemented in 50–60 countries.[1,2] The use of collars is, in fact, regarded as so important that it is highlighted in the well-known ABCs of major trauma as a first measure, together with establishment of free airways.[3]

Collars were introduced to prevent secondary injury to the spinal cord by immobilizing a potentially unstable spine.[4,5] Many years have passed since, and this practice has evolved into a hallmark of modern state-of-the-art prehospital care.[6,7] Millions of trauma patients are currently fitted with a collar every year.[8] However, as evaluated in a Cochrane review in 2001 (updated in 2007), the documented evidence for our ongoing practice is rather limited: Randomized, controlled trials (RCTs) are largely missing, and there are uncertain effects on mortality, neurological injury, and spinal stability.[9] Moreover, and perhaps more concerning, there is a growing body of evidence and opinion against the use of collars.[8–14]

Improving prehospital management has a substantial effect on society as a whole and is a high-priority research area.[15] In this review, we argue that it is time to reconsider the unjustified dogma of collar use in prehospital trauma care.

Methods

We performed a literature search in the Medline database using a combination of relevant medical subject headings (MeSHs) and text words: ("cervical vertebrae"[MeSH] or "neck"[MeSH] or cervical[text word]) *and* ("braces"[MeSH] *or collar*[text word]) *or* "immobilization"[MeSH]) *and* ("wounds and injuries"[MeSH] or "emergency medical services"[MeSH]). This search was limited to human studies in English available by April 2013. All authors contributed to the search strategy development. We found 1018 publications, of which 88 titles were considered relevant by one or two independent authors (T.S. and K.W.). Borderline titles were included. These publications underwent full review by the author group, and 50 articles were found relevant to prehospital use of collars in trauma patients by more than one author. These articles are included here. Finally, we searched the reference lists of retrieved articles and contacted experts in the field to identify pertinent studies. Articles published over the last 10–15 years were prioritized.

Epidemiology of Cervical Spine and Spinal Cord Injuries

Several reports state that approximately 2–4% of trauma patients have cervical spine injuries (CSIs),[16–18] of which roughly 20%

[1]Department of Biomedicine, [2]Department of Clinical Medicine K1, University of Bergen, Bergen, Norway;
[3]Department of Neurosurgery, Haukeland University Hospital, Bergen, Norway;
[4]Department of Anesthesia and Intensive Care, Haukeland University Hospital, Bergen, Norway;
[5]Helicopter Emergency Medical Services, Bergen, Norway;
[6]The Norwegian Air Ambulance Foundation, Drobak, Norway.

ORIGINAL ARTICLE

Prehospital Spinal Immobilization Does Not Appear to Be Beneficial and May Complicate Care Following Gunshot Injury to the Torso

Joshua B. Brown, BA, Paul E. Bankey, MD, PhD, Ayodele T. Sangosanya, MD, Julius D. Cheng, MD, Nicole A. Stassen, MD, and Mark L. Gestring, MD

Background: Prehospital spinal immobilization (PHSI) is routinely applied to patients sustaining torso gunshot wounds (GSW). Our objective was to evaluate the potential benefit of PHSI after torso GSW versus the potential to interfere with other critical aspects of care.
Methods: A retrospective analysis of all patients with torso GSW in the Strong Memorial Hospital (SMH) trauma registry during a 41-month period and all patients with GSW in the National Trauma Data Bank (NTDB) during a 60-month period was conducted. PHSI was considered potentially beneficial to patients with spine fractures requiring surgical stabilization in the absence of spinal cord injury (SCI).
Results: Three hundred fifty-seven subjects from SMH and 75,210 from NTDB were included. A total of 9.2% of SMH subjects and 4.3% of NTDB subjects had spine injury, with 51.3% of SMH subjects and 32.3% of NTDB subjects having SCI. No SMH subject had an unstable spine fracture requiring surgical stabilization without complete neurologic injury. No subjects with SCI improved or worsened, and none developed a new deficit. Twenty-six NTDB subjects (0.03%) had spine fractures requiring stabilization in the absence of SCI. Emergent intubation was required in 48.4% of SMH subjects and 33.4% of NTDB subjects. Emergent surgical intervention was required in 54.3% of SMH subjects and 4.9% of NTDB subjects.
Conclusions: Our data suggest that the benefit of PHSI in patients with torso GSW remains unproven, despite a potential to interfere with emergent care in this patient population. Large prospective studies are needed to clarify the role of PHSI after torso GSW.
Key Words: Spinal cord injury, Gunshot wound, Spinal immobilization, Prehospital care.

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Gunshot injury remains a significant public health problem, accounting for almost 20% of all trauma deaths in the United States.[1] The management of gunshot wounds (GSW) is frequently initiated at the scene of injury, with the routine application of prehospital spinal immobilization (PHSI). Although commonly used, the role of the cervical collar, rigid backboard, and spinal precautions after GSW to the torso is not clear and may, in fact, interfere with other treatment modalities.

The role of PHSI is not controversial after blunt trauma, where patients felt to be at risk for spinal cord injury (SCI) are immobilized to prevent the manipulation of a potentially unstable vertebral column during subsequent transport and treatment. The literature, however, reports the occurrence of unstable spine fractures after GSW to be extremely rare, and some have questioned the role of spinal immobilization in this patient population.[2–4] The purpose of this study was to evaluate whether PHSI afforded any benefit after torso GSW and, furthermore, whether its application in this patient population complicated or delayed early treatment efforts.

MATERIALS AND METHODS

Two data sets were examined during this analysis (Fig. 1). First, the trauma registry at Strong Memorial Hospital (SMH), a New York State–designated level I trauma center, was retrospectively reviewed to identify all subjects sustaining a torso GSW during a 41-month period from January 1, 2003, to June 1, 2007. Subjects were excluded if they were noted to have concurrent blunt mechanism of injury or isolated GSW to the head, neck, or extremities. Data regarding prehospital times, immobilization, airway management, emergency department (ED) disposition, and need for non–spine-related emergent surgical intervention (ESI) were collected. Medical records were further reviewed to identify all subjects in this group who sustained injury to the spine. Specific characteristics related to spine injury were further collected, including presence or absence of neurologic deficits, indication for decision to proceed with surgical stabilization of the spine, and any changes in neurologic status during hospitalization. The theoretic benefit of PHSI is to prevent secondary SCI caused by excessive manipulation of an unstable spinal column. Thus, PHSI was regarded as potentially beneficial in subjects without complete SCI who went on to require surgical stabilization of an unstable vertebral fracture.

Second, to assess similar variables in a larger national sample, the National Trauma Data Bank (NTDB) version 6.2 was queried using International Classification of Diseases (ICD)-9 E-codes to identify all subjects who sustained a GSW between the years 2001 and 2005 (Table 1). Any subject with a primary injury type of "blunt" was excluded. From this group, the following variables were collected—age, sex, injury severity score (ISS), ED disposition, and intubation type. The need for ESI was defined as an ED

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Presented as a poster at the 67th Annual Meeting of the American Association for the Surgery of Trauma, September 24–27, 2008, Maui, Hawaii.
Address for reprints: Mark L. Gestring, MD, FACS, Strong Regional Trauma Center, Department of Surgery, University of Rochester School of Medicine, 601 Elmwood Avenue, Box 611RL, Rochester, New York, 14642-8410; email: mark_gestring@urmc.rochester.edu.

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Prehospital Intravenous Fluid Administration Is Associated With Higher Mortality in Trauma Patients: A National Trauma Data Bank Analysis

Elliott R. Haut, MD, Brian T. Kalish, BA*, Bryan A. Cotton, MD, MPH†, David T. Efron, MD*, Adil H. Haider, MD, MPH*‡, Kent A. Stevens, MD, MPH*‡, Alicia N. Kieninger, MD§, Edward E. Cornwell, III, MD¶, and David C. Chang, MBA, MPH, PhD‖*

Objective: Prehospital intravenous (IV) fluid administration is common in trauma patients, although little evidence supports this practice. We hypothesized that trauma patients who received prehospital IV fluids have higher mortality than trauma patients who did not receive IV fluids in the prehospital setting.

Methods: We performed a retrospective cohort study of patients from the National Trauma Data Bank. Multiple logistic regression was used with mortality as the primary outcome measure. We compared patients with versus without prehospital IV fluid administration, using patient demographics, mechanism, physiologic and anatomic injury severity, and other prehospital procedures as covariates. Subset analysis was performed based on mechanism (blunt/penetrating), hypotension, immediate surgery, severe head injury, and injury severity score.

Results: A total of 776,734 patients were studied. Approximately half (49.3%) received prehospital IV. Overall mortality was 4.6%. Unadjusted mortality was significantly higher in patients receiving prehospital IV fluids (4.8% vs. 4.5%, $P < 0.001$). Multivariable analysis demonstrated that patients receiving IV fluids were significantly more likely to die (odds ratio [OR] 1.11, 95% confidence interval [CI] 1.05–1.17). The association was identified in nearly all subsets of trauma patients. It is especially marked in patients with penetrating mechanism (OR 1.25, 95% CI 1.08–1.45), hypotension (OR 1.44, 95% CI 1.29–1.58), severe head injury (OR 1.34, 95% CI 1.17–1.54), and patients undergoing immediate surgery (OR 1.35, 95% CI 1.22–1.50).

Conclusions: The harm associated with prehospital IV fluid administration is significant for victims of trauma. The routine use of prehospital IV fluid administration for all trauma patients should be discouraged.

(*Ann Surg* 2011;253:371–378)

The administration of intravenous (IV) fluids has been a key component of the prehospital treatment of trauma patients since the advent of paramedic emergency medical systems (EMS). Prehospital IV fluid resuscitation is intended to hemodynamically stabilize trauma patients by replacing intravascular volume and maintaining vital organ perfusion.[1] Since its inception, the American College of Surgeons Advanced Trauma Life Support course has emphasized immediate treatment of trauma patients with IV fluids, although in the newest eighth edition, the course now emphasizes a more "balanced" approach.[2] The routine practice of IV fluid administration in the prehospital arena is touted with great enthusiasm but little data exist to support its use.[3,4]

An increasing body of evidence has demonstrated that IV fluid administration does not improve survival in trauma and may actually be of harm in certain subsets of trauma patients.[5–9] One theory for the possibility of harm is based upon the delay of transport to definitive care. Scene placement of venous access is not only associated with increased scene time but also increased overall time to hospital, in some cases the time to place an IV exceeds that of the actual transport itself.[10] In hypotensive patients and those with primary torso injuries, scene placement times exceed that of en route IV line placement.[11,12] Many trauma providers believe that the "scoop and run" approach, which minimizes prehospital procedures in favor of rapid transport to definitive care, is preferable to the "stay and play" model of prehospital trauma care.[13,14]

The second main theory regarding the potential harm of IV fluids is based upon the idea of "popping the clot." This theory suggests that in patients, who have stopped bleeding temporarily from vasoconstriction and hypotension, IV fluids will raise systolic blood pressure and cause patients to rebleed if their bleeding source is not yet surgically controlled. This theory is supported by one of the few prospective randomized studies of prehospital IV fluid resuscitation in trauma patients. Bickell et al[15] showed that delaying aggressive fluid resuscitation until surgery significantly improved outcome in hypotensive patients with penetrating torso injuries. On the basis of these data, a new Eastern Association for the Surgery of Trauma practice management guideline advocates limited prehospital IV fluid resuscitation.[16]

Given the previous data, we chose to examine the impact of prehospital IV catheter placement and fluid administration on survival following traumatic injury using the National Trauma Data Bank (NTDB), which is the largest dataset of trauma patients ever created. We hypothesize that trauma patients receiving prehospital IV catheter placement (with or without IV fluids) have higher mortality than trauma patients who did not receive an IV or fluids.

METHODS

This retrospective study used 5 years (2001–2005) worth of data from the American College of Surgeons NTDB (Version 6.2). The NTDB is the largest collection of trauma data, with approximately 1.5 million records from more than 600 US trauma centers. Data from the NTDB are deidentified to comply with The Health Insurance Portability and Accountability Act (HIPAA) regulations. Institutional review board exemption was obtained from the Johns Hopkins institutional review board. All trauma patients who suffered

From the *Division of Acute Care Surgery, Department of Surgery, The Johns Hopkins University School of Medicine, Baltimore, MD; †Department of Surgery and The Center for Translational Injury Research, The University of Texas Health Science Center, Houston, TX; ‡Center for Surgical Trauma Research, Policy and Management, The Johns Hopkins University Bloomberg School of Public Health; §Department of Surgery, Washington University School of Medicine, St. Louis, MO; ¶Department of Surgery, Howard University College of Medicine, Washington, DC; and ‖Director of Outcomes Research, Department of Surgery, University of California San Diego, San Diego, CA.

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Reprints: Elliott R. Haut, MD, FACS, Division of Acute Care Surgery, Department of Surgery, The Johns Hopkins Hospital, 600 N. Wolfe St, A237 Osler, Baltimore, MD 21287. E-mail: ehaut1@jhmi.edu.

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BMJ

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CLINICAL REVIEW

Early fluid resuscitation in severe trauma

Tim Harris *professor of emergency medicine*[1,2], G O Rhys Thomas *Lieutenant Colonel and honorary consultant*[3,4,2], Karim Brohi *professor of trauma sciences and consultant trauma and vascular surgeon*[1,2]

[1]Barts and the London School of Medicine and Dentistry, Queen Mary University of London, London, UK; [2]Barts Health NHS Trust, London; [3]16 Air Assault Medical Regiment; [4]Royal London and Queen Victoria, East Grinstead, UK

Trauma is a global health problem that affects patients in both rich and poor countries and accounts for 10 000 deaths each day.[1,2] Trauma is the second leading cause of death after HIV/AIDS in the 5-45 year old age group.[3,4] Early triage and resuscitation decisions affect outcome in trauma situations.[4,5,6] The two leading causes of mortality in trauma are neurological injury and blood loss.[1,4,5,6,7,8] There has been considerable improvement in our understanding of trauma resuscitation in the past 20 years, and data from databases and observational trials suggests outcomes are improving.[9] For patients with severe traumatic injuries (defined as >15 by the injury severity score, an anatomical scoring system), the high volume fluid resuscitation promoted by early advanced trauma life support manuals,[7] followed by definitive surgical care, has given way to a damage control resuscitation (DCR) strategy (box).

This DCR approach has seen a fall in the volume of crystalloid delivered in the emergency department and an associated fall in mortality.[4,10] In this review, we summarise the evidence guiding the initial period of resuscitation from arrival in the emergency department to transfer to intensive care or operating theatre, focusing on trauma in critically injured adults. This article emphasises newer developments in trauma care. There is debate on whether patients with brain injury should be resuscitated to higher blood pressures, which is briefly discussed later in the text.

How can patients who need DCR be identified?

A DCR strategy applies to patients who present with suspected major haemorrhage. While many definitions exist, the most practical in the acute trauma setting is for estimated blood transfusion volumes of over four units in the initial 2-4 h. Identifying these patients can be a challenge because they are often young with good physiological reserve and may have no physiological evidence of hypovolaemic shock.[7] A number of tools have been developed to identify this group of patients; however, physician decision and experience have been found to be just as accurate,[11,12,13,14,15] Failure to identify these patients early and to apply DCR is associated with excess mortality.[4]

How can trauma patients in shock be identified?

Shock may be defined as a life threatening condition characterised by inadequate delivery of oxygen to vital organs in relation to their metabolic requirements.[7] A systolic blood pressure of 90 mm Hg is commonly used to define both hypotension and shock; however, oxygen delivery depends on cardiac output rather than blood pressure. Homeostasis with peripheral vasoconstriction acts to preserve blood pressure even as circulating volume is lost. In patients who have had trauma, adequate cardiac output cannot be inferred from blood pressure. Only when blood loss approaches half the circulating volume or occurs rapidly is there a relation between the cardiac output and blood pressure.[16] Patients presenting with hypotension, tachycardia, and obvious blood loss are readily identified as being in a state of haemorrhagic shock. However, many patients will maintain their pulse and blood pressure even after massive blood loss and tissue hypoxia. This condition is termed cryptic shock and is associated with increased mortality.[4,17]

The role of basic physiological parameters to estimate the severity of blood loss has been popularised in the advanced trauma life support courses and manuals.[7] These materials describe physiological deterioration with increasing volumes of blood loss, and categorise four stages of shock. But data from a 1989-2007 analysis of the United Kingdom Trauma Audit Research Network database suggest that this model is not reflected in practice. Patients with progressive levels of blood loss to stage 4 haemorrhagic shock (equating to >2 L blood loss) were found to increase their pulse rates from 82 to 95 beats per minute, not to change respiratory rates or Glasgow coma scale,

Correspondence to: T Harris, Department of Emergency Medicine, Royal London Hospital, Whitechapel, London E1 1BB tim.harris@bartshealth.nhs.uk

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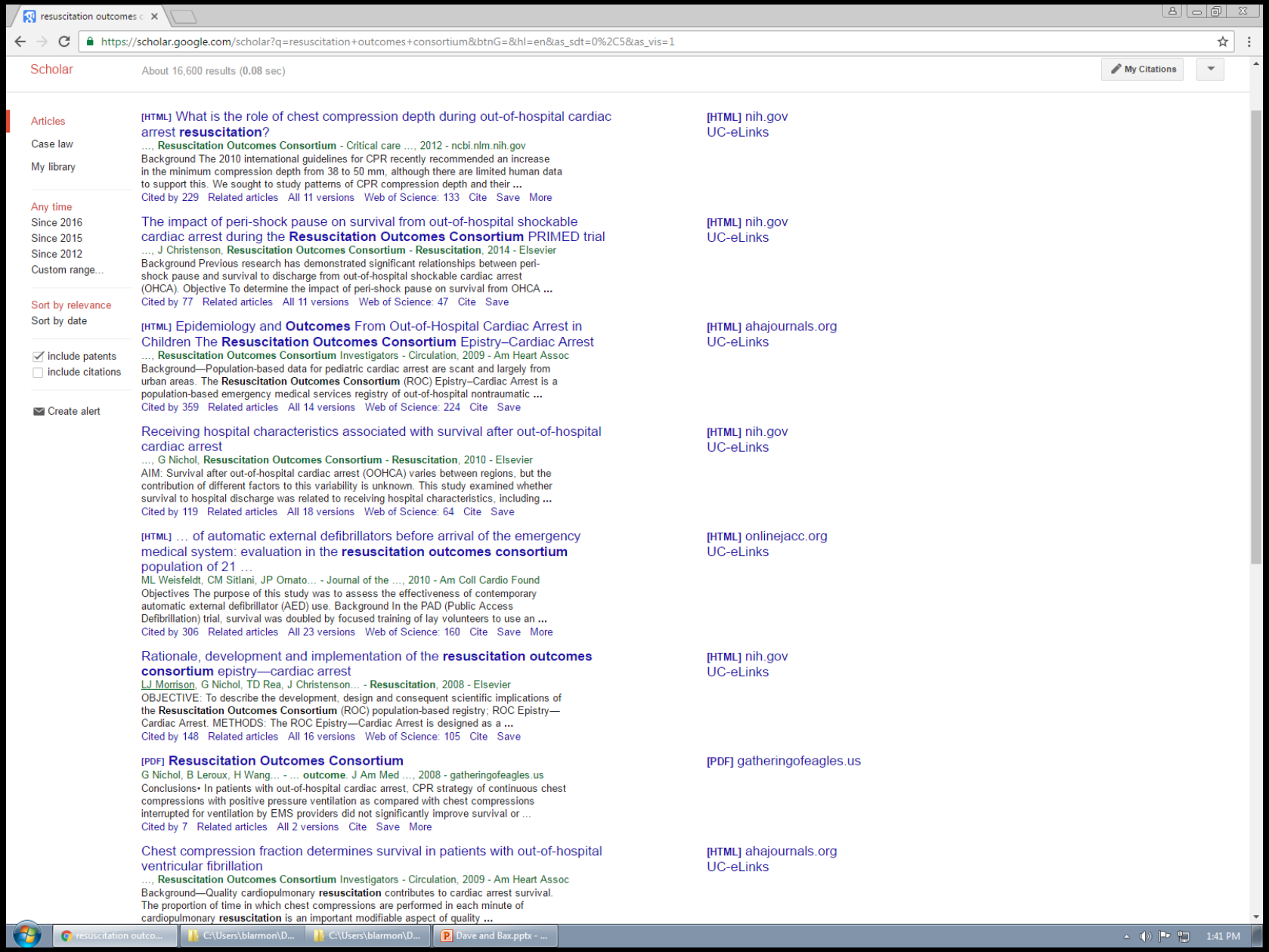
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[HTML] What is the role of chest compression depth during out-of-hospital cardiac arrest resuscitation?
..., Resuscitation Outcomes Consortium - Critical care ..., 2012 - ncbi.nlm.nih.gov
Background The 2010 international guidelines for CPR recently recommended an increase in the minimum compression depth from 38 to 50 mm, although there are limited human data to support this. We sought to study patterns of CPR compression depth and their ...
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The impact of peri-shock pause on survival from out-of-hospital shockable cardiac arrest during the Resuscitation Outcomes Consortium PRIMED trial
..., J Christenson, Resuscitation Outcomes Consortium - Resuscitation, 2014 - Elsevier
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 ...
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Background—Population-based data for pediatric cardiac arrest are scant and largely from urban areas. The Resuscitation Outcomes Consortium (ROC) Epistry–Cardiac Arrest is a population-based emergency medical services registry of out-of-hospital nontraumatic ...
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Receiving hospital characteristics associated with survival after out-of-hospital cardiac arrest
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AIM: Survival after out-of-hospital cardiac arrest (OOHCA) 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 ...
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Objectives The purpose of this study was to assess the effectiveness of contemporary automatic external defibrillator (AED) use. Background In the PAD (Public Access Defibrillation) trial, survival was doubled by focused training of lay volunteers to use an ...
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Rationale, development and implementation of the resuscitation outcomes consortium epistry—cardiac arrest
LJ Morrison, G Nichol, TD Rea, J Christenson... - Resuscitation, 2008 - Elsevier
OBJECTIVE: To describe the development, design and consequent scientific implications of the Resuscitation Outcomes Consortium (ROC) population-based registry; ROC Epistry—Cardiac Arrest. METHODS: The ROC Epistry—Cardiac Arrest is designed as a ...
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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 ...
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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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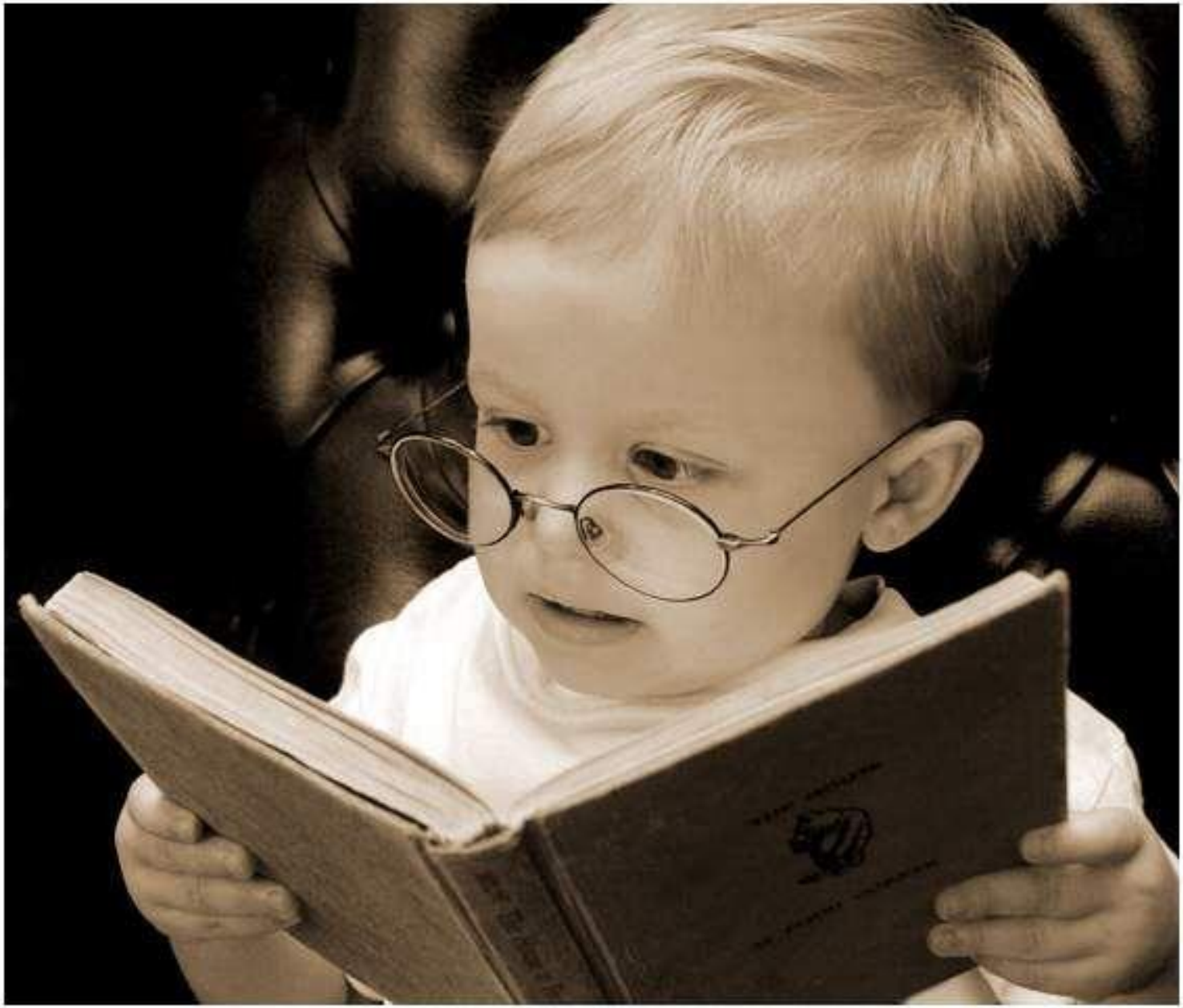

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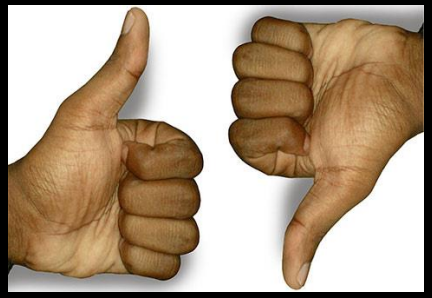

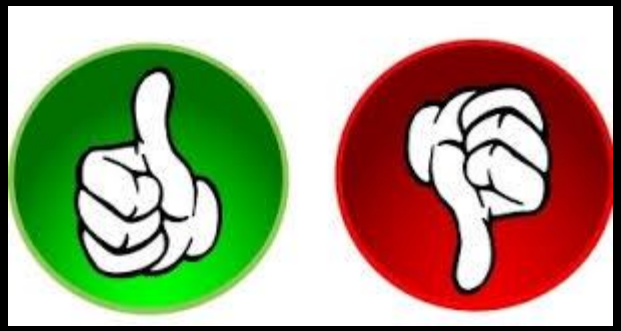

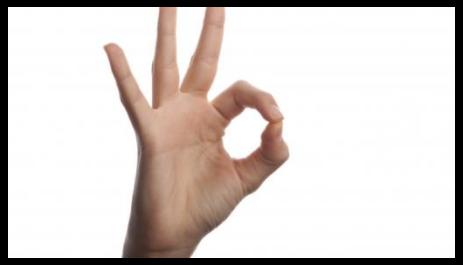

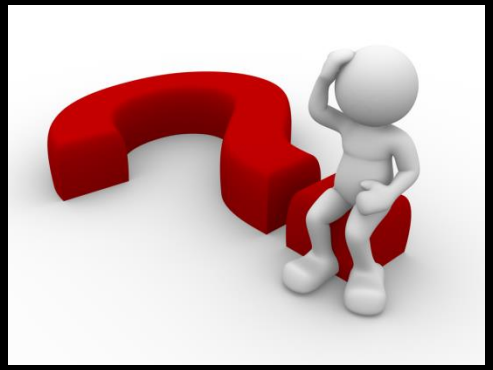


Question

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doi:10.1093/eurheartj/eht369

FASTTRACK CLINICAL RESEARCH

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[1]*, Michael R. Schmidt[1], Kim Munk[1], Rajesh K. Kharbanda[2], Andrew N. Redington[3], Morten Schmidt[4], Lars Pedersen[4], Henrik T. Sørensen[4], and Hans Erik Bøtker[1], CONDI Investigators

[1]Department of Cardiology, Aarhus University Hospital, Aarhus N, Denmark; [2]Oxford University Hospitals, John Radcliffe Hospital, Oxford, UK; [3]Division of Cardiology, Hospital for Sick Children, Toronto, Canada; and [4]Department of Clinical Epidemiology, Aarhus University Hospital, Aarhus N, Denmark

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See page 138 for the editorial comment on this article (doi:10.1093/eurheartj/eht478)

Aims Remote ischaemic conditioning as an adjunct to primary percutaneous coronary intervention in patients with ST-elevation myocardial infarction increases myocardial salvage. We investigated the effect of remote ischaemic conditioning on long-term clinical outcome.

Methods and results From February 2007 to November 2008, 333 patients with a suspected first acute ST-elevation myocardial infarction were randomized to receive primary percutaneous coronary intervention with ($n = 166$) or without ($n = 167$) remote ischaemic conditioning (intermittent arm ischaemia through four cycles of 5-min inflation followed by 5-min deflation of a blood-pressure cuff). Patient follow-up extended from the randomization date until an outcome, emigration or January 2012 (median follow-up = 3.8 years). The primary endpoint was major adverse cardiac and cerebrovascular events (MACCE)—a composite of all-cause mortality, myocardial infarction, readmission for heart failure, and ischaemic stroke/transient ischaemic attack. The individual components of the primary endpoint comprised the secondary end-