RUTGERS

THE STATE UNIVERSITY
OF NEW JERSEY

Beyond ACLS - Cardiac Arrest for the Resuscitationist

Joshua Bucher, M.D.
EMS Fellow
Morristown Memorial Hospital

Disclosures

Objectives

- How to manage intra-arrest
- How to manage post-arrest
- How to manage recurrent/refractory arrhythmia
- How to optimize neurologic resuscitation
- How to manage intra-arrest in the future

G Model
RESUS 6297 1–8

ARTICLE IN PRESS

Resuscitation xxx (2015) xxx–xxx

ELSEVIER

Contents lists available at ScienceDirect

Resuscitation

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

RESUSCITATION

Clinical paper

Out-of-hospital cardiac arrest survival improving over time: Results from the Resuscitation Outcomes Consortium (ROC)☆

Mohamud R. Daya[a,*], Robert H. Schmicker[b], Dana M. Zive[a], Thomas D. Rea[c], Graham Nichol[b,c], Jason E. Buick[d], Steven Brooks[e], Jim Christenson[f], Renee MacPhee[g], Alan Craig[d], Jon C.
Henry Wang[k], for

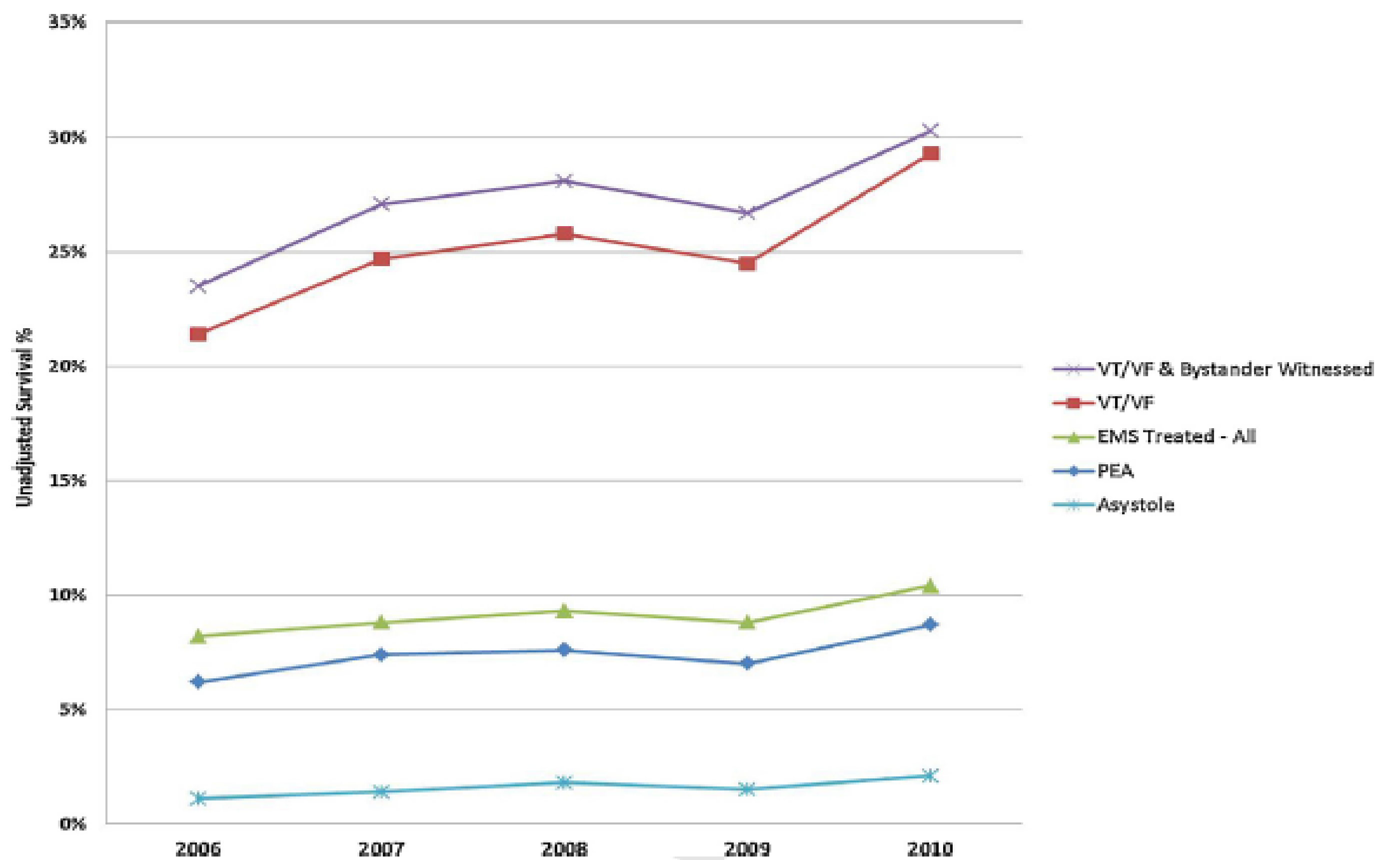
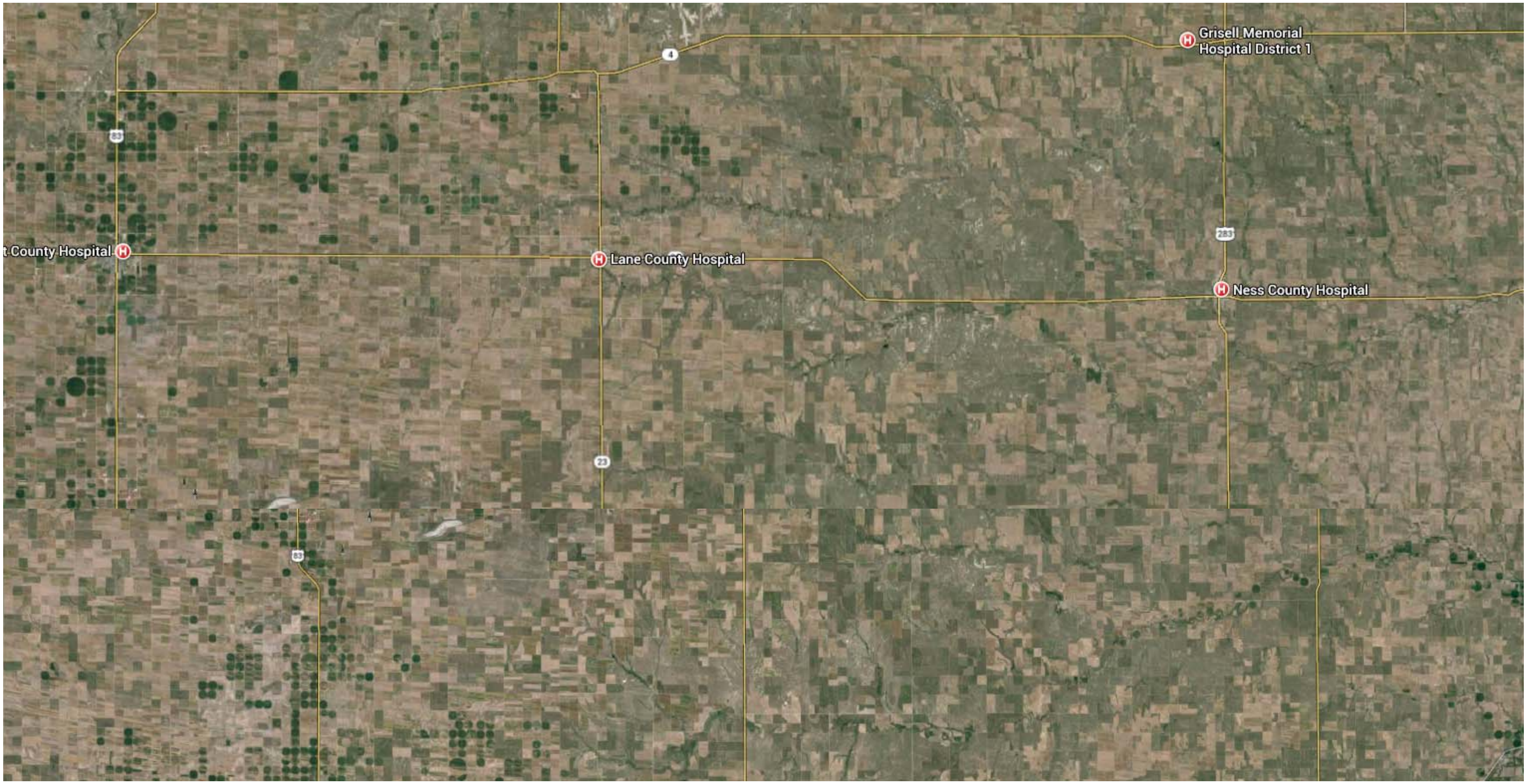
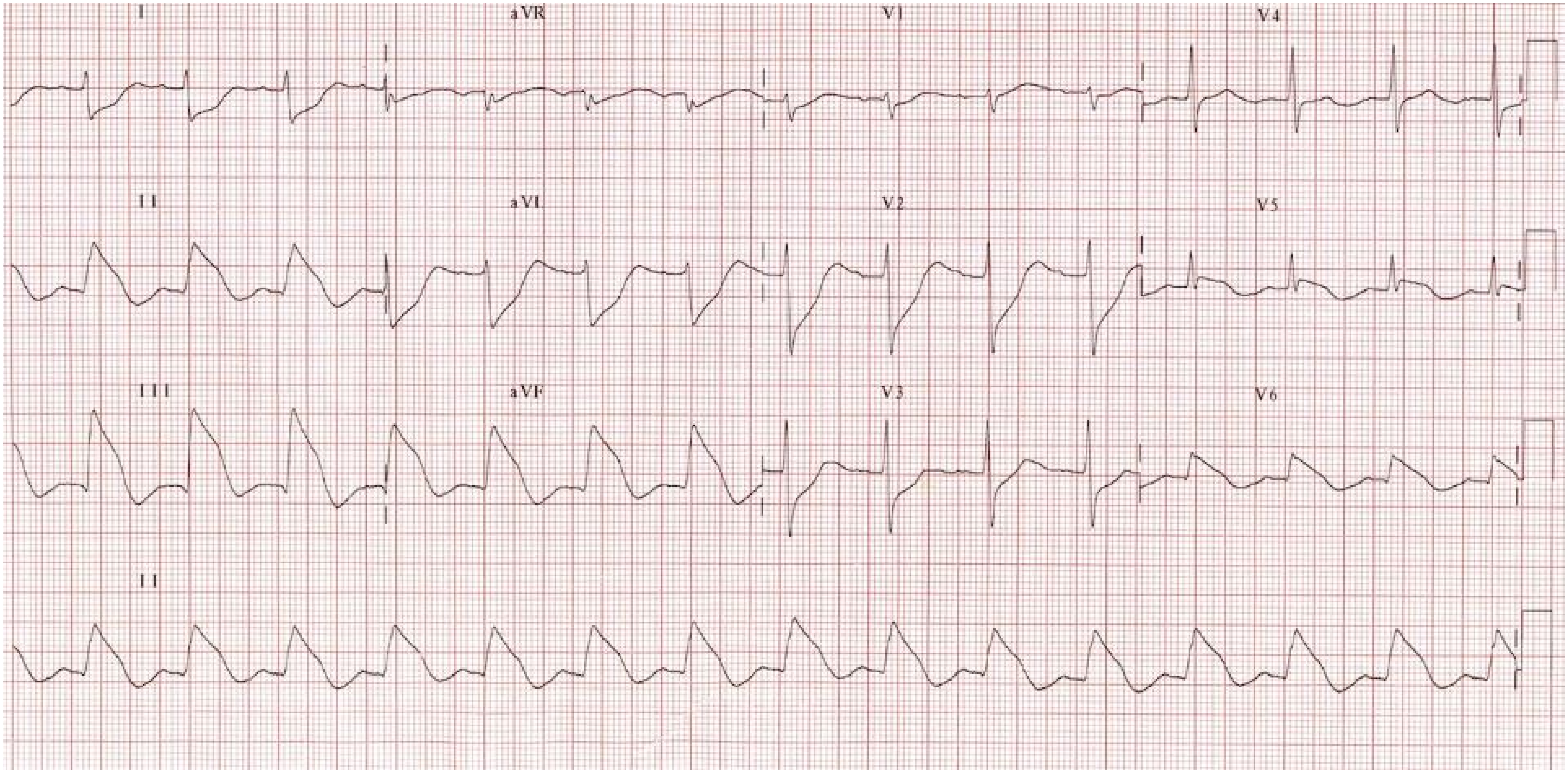


Fig. 2. Out of hospital cardiac arrest survival over time – all sites and rhythm groups.

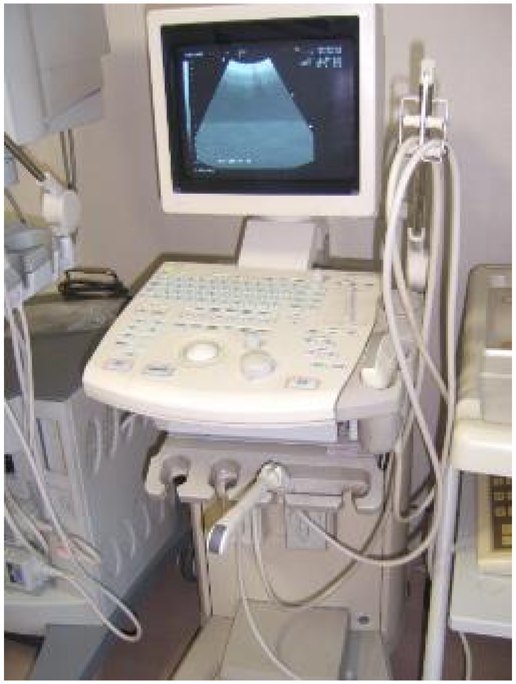

Lane County Hospital
S 2nd St
S 1st St
W Vine St


Grisell Memorial
Hospital District 1
4
83
t County Hospital
Lane County Hospital
283
Ness County Hospital
23
83

Medic phone rings…

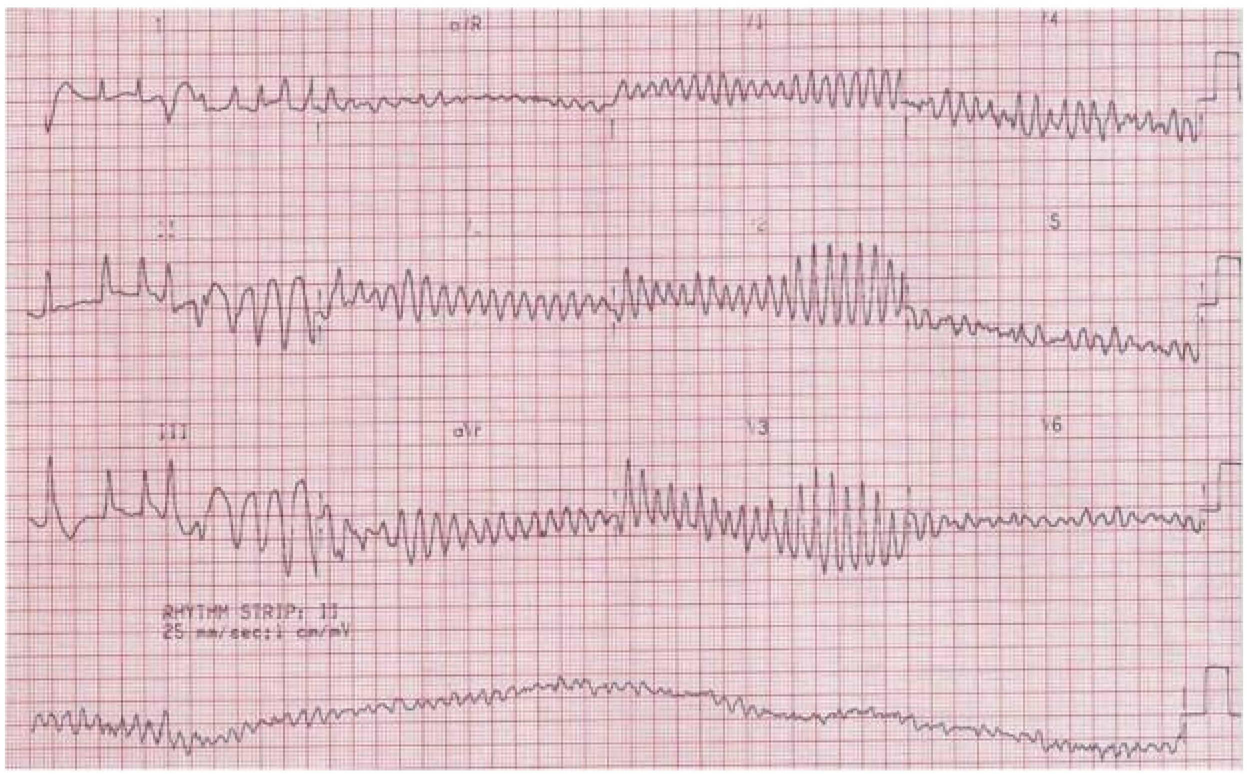


What do you do?



Patient Arrival

- CPR Ongoing
- PMHx – HTN
- Meds – HCTZ
- All – NKDA
- Current rhythm



INTRA ARREST MANAGEMENT

Resuscitation 85 (2014) 1488–1493

Contents lists available at ScienceDirect

Resuscitation

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

Clinical Paper

Survival rates in out-of-hospital cardiac arrest patients transported without prehospital return of spontaneous circulation: An observational cohort study☆

Ian R. Drennan[a,b,c,*], Steve Lin[a,d], Daniel E. Sidalak[a], Laurie J. Morrison[a,b,d]

[a] Rescu, Li Ka Shing Knowledge Institute, St. Michael's Hospital, Toronto, Canada
[b] Institute of Medical Science, Department of Medicine, University of Toronto, Toronto, Canada
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[d] Division of Emergency Medicine, Department of Medicine, University of Toronto, Toronto, Canada

AIRWAY MANAGEMENT

Airway

- Intubate?
- NRB at 15 LPM?
- Supraglottic airway?
- BVM with oral airway?
- Nothing?
- Ventilator?

Actual Management

OOH

- Bystander
  - Nothing
- EMT
  - BVM
- Paramedic
  - ETI

ED

- ETI

Advanced Airway Management Does Not Improve Outcome of Out-of-hospital Cardiac Arrest

M. Arslan Hanif, MD, Amy H. Kaji, MD, PhD, and James T. Niemann, MD

ACAD EMERG MED • September 2010, Vol. 17, No. 9 • www.aemj.org 929

Table 2
Univariate and Multivariable Analysis for BVM/ETI for SHD

Predictor Variable for SHD	Univariate OR (95% CI)	Multivariable OR (95% CI)
BVM vs. ETI	3.30 (1.8–6.3) p = 0.0002	4.5 (2.3–8.9) p < 0.0001
VT/VF vs. all other rhythms	8.60 (2.7–27.9) p <0.0001	9.3 (2.6–33.4) p = 0.0006
Witnessed vs. unwitnessed	4.10 (2.2–7.7) p < 0.0001	5.5 (2.8–11.1) p < 0.0001
Bystander CPR vs. no bystander CPR	1.20 (0.7–2.0) p = 0.6	1.5 (0.8–2.7) p = 0.2
Nursing home vs. all other sites of arrest	0.40 (0.2–0.9) p = 0.03	0.4 (0.2–0.9) p = 0.03
Male vs. female	0.90 (0.6–1.6) p = 0.9	0.9 (0.5–1.6) p = 0.7
Age	0.99 (0.97–1.00) p = 0.3	1.0 (0.98–1.02) p = 0.9

BVM/ETI = bag-valve-mask ventilation/endotracheal intubation; CPR = cardiopulmonary resuscitation; SHD = survival to hospital discharge; VF/VT = ventricular fibrillation/ventricular tachycardia.

Assessing Impact of PreHospital Intubation on Survival from OOHCA
Egly et al. PEC. Jan 2011.

TABLE 3. Multivariable Logistic Regression Analysis of the Association of Survival to Discharge (Ventricular Fibrillation/Ventricular Tachycardia)

	Survival to Discharge Adjusted OR (95% CI)
Intubation status	
ETI	0.52 (0.27, 0.998)
No ETI	1.00
Witnessed cardiac arrest	
Yes	2.75 (1.36, 5.56)
No	1.00

Goodness of fit: Hosmer-Lemeshow. Ventricular fibrillation/ventricular tachycar
p = 0.92.
CI = confidence interval; ET = endotrachea

48 PREHOSPITAL EMERGENCY CARE JANUARY/MARCH 2011 VOLUME 15 / NUMBER 1

TABLE 4. Logistic Regression Analysis of the Association of Survival to Admission with Sample Characteristics in Patients Who Did Not Have Ventricular Fibrillation/Ventricular Tachycardia ($n = 742$)

	Prevalence (% Survived to Admission)	OR (95% CI)	Prevalence (% Survived to Discharge)	OR (95% CI)
Intubation status				
ETI	13.5	2.94 (1.16, 7.44)	1.8	1.83 (0.23, 14.36)
No ETI	5.0	1.00	1.0	1.00
Age				
80+ years	11.3	0.88 (0.53, 1.46)	1.5	0.81 (0.22, 3.02)
<80 years	12.7	1.00	1.8	1.00
Witnessed cardiac arrest				
Yes	14.8	2.68 (1.46, 4.91)	1.5	0.95 (0.25, 3.57)
No	6.1	1.00	1.6	1.00
Location				
Home	13.1	1.36 (0.78, 2.39)	2.1	3.63 (0.46, 28.28)
Other	9.9	1.00	0.6	1.00
Bystander CPR				
Yes	9.9	0.72 (0.35, 1.51)	0.00	
No	13.2	1.00	1.8	—

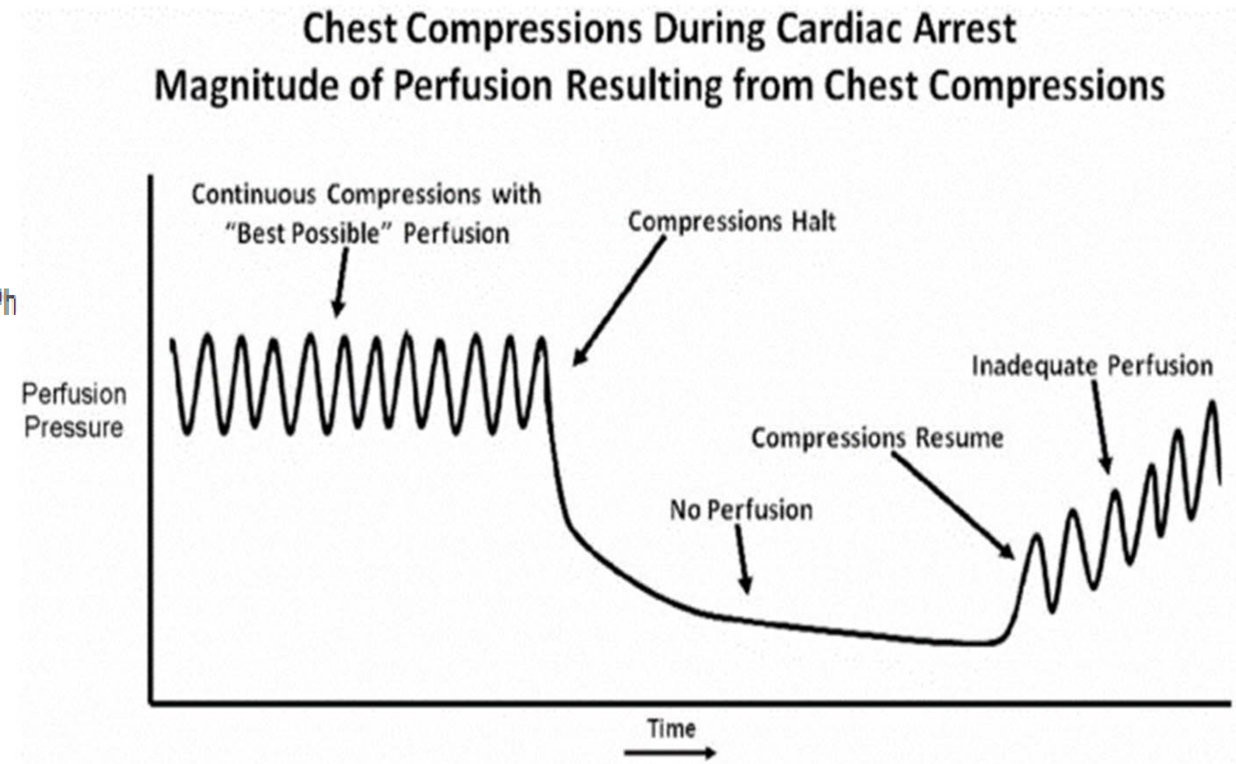
CI = confidence interval; CPR = cardiopulmonary resuscitation; ET = endotracheal intubation; OR = odds ratio.

EMERGENCY MEDICAL SERVICES/ORIGINAL RESEARCH

Interruptions in Cardiopulmonary Resuscitation From Paramedic Endotracheal Intubation

Annals of EM

Henry E. Wang, MD, MS
Scott J. Simeone, BS, NREMT-P
Matthew D. Weaver, BS, NREMT-P
Clifton W. Callaway, MD, Ph



http://rebelem.com/cpr-hands-hands-defibrillation/

CARING FOR THE CRITICALLY ILL PATIENT

Association of Prehospital Advanced Airway Management With Neurologic Outcome and Survival in Patients With Out-of-Hospital Cardiac Arrest

Kohei Hasegawa, MD, MPH
Atsushi Hiraide, MD, PhD
Yuchiao Chang, PhD
David F. M. Brown, MD

Importance It is unclear whether advanced airway management such as endotracheal intubation or use of supraglottic airway devices in the prehospital setting improves outcomes following out-of-hospital cardiac arrest (OHCA) compared with conventional bag-valve-mask ventilation.

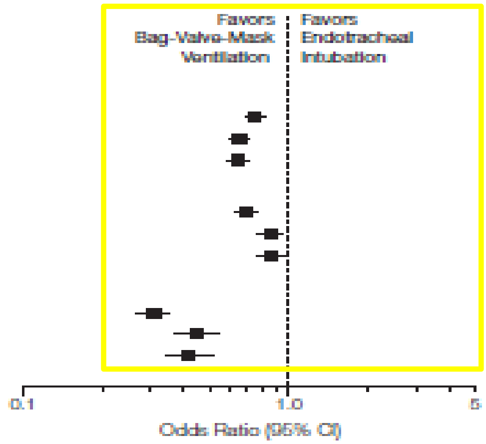
JAMA. 2013;309(3):257-266

Advanced Cardiac Arrest

Figure 2. Results of Conditional Logistic Regression Models Using One of the End Points as a Dependent Variable With Propensity-Matched Patients

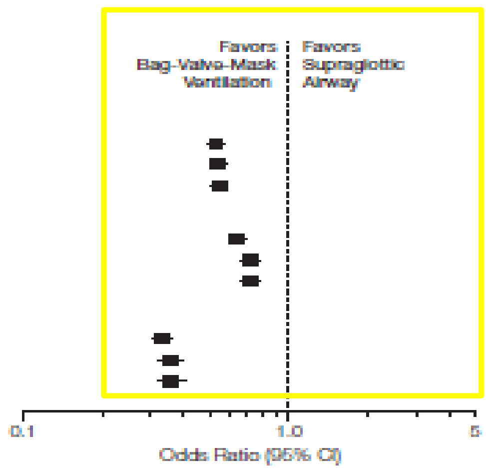
A Endotracheal intubation vs bag-valve-mask ventilation

Model	Total No. of Patients	No. (%) Endotracheal Intubation	No. (%) Bag-Valve-Mask Ventilation	Odds Ratio (95% CI)[a]
Total		26 013 (7.3)	178 614 (50.0)	
Return of spontaneous circulation				
Unadjusted	357 228	1734 (6.7)	14 824 (8.3)	0.76 (0.71-0.81)
Adjusted for selected variables[b]				0.66 (0.61-0.72)
Adjusted for all variables[c]				0.64 (0.58-0.70)
1-month survival				
Unadjusted	357 228	1069 (4.1)	10 373 (5.8)	0.70 (0.65-0.76)
Adjusted for selected variables[b]				0.87 (0.79-0.97)
Adjusted for all variables[c]				0.88 (0.79-0.98)
Neurologically favorable survival				
Unadjusted	357 228	257 (1.0)	5799 (3.2)	0.31 (0.27-0.35)
Adjusted for selected variables[b]				0.45 (0.37-0.55)
Adjusted for all variables[c]				0.42 (0.34-0.53)



B Supraglottic airway vs bag-valve-mask ventilation

Model	Total No. of Patients	No. (%) Supraglottic Airway	No. (%) Bag-Valve-Mask Ventilation	Odds Ratio (95% CI)[a]
Total		152 601 (42.7)	178 614 (50.0)	
Return of spontaneous circulation				
Unadjusted	357 228	6933 (4.5)	14 824 (8.3)	0.53 (0.51-0.54)
Adjusted for selected variables[b]				0.54 (0.52-0.56)
Adjusted for all variables[c]				0.54 (0.52-0.56)
1-month survival				
Unadjusted	357 228	5718 (3.8)	10 373 (5.8)	0.63 (0.61-0.65)
Adjusted for selected variables[b]				0.71 (0.68-0.74)
Adjusted for all variables[c]				0.72 (0.68-0.75)
Neurologically favorable survival				
Unadjusted	357 228	1697 (1.1)	5799 (3.2)	0.33 (0.32-0.35)
Adjusted for selected variables[b]				0.36 (0.33-0.39)
Adjusted for all variables[c]				0.36 (0.33-0.40)



Full models for the primary outcome analysis are included in eTable 2.
[a] For all odds ratios, $P < .001$.
[b] Selected variables are a predefined set of potential confounders including age, sex, cause of cardiac arrest, first documented rhythm, bystander witness, type of cardiopulmonary resuscitation (CPR) initiated by a bystander, use of public access automated external defibrillator by bystander, epinephrine administration, time from receipt of call to CPR by emergency medical service, and time from receipt of call to hospital arrival.
[c] All variables included all covariates in Table 1 and variables for 47 prefectures in Japan.

BREATHING

Incidence of Agonal Respirations in Sudden Cardiac Arrest

Jill J Clark*
Mary Pat Larsen, MS*
Linda L Culley*
Judith Reid Graves, RN, MA*
Mickey S Eisenberg, MD, PhD*+

Study objective: To discover the frequency of agonal respirations in cardiac arrest calls, the ways callers describe them, and discharge rates associated with agonal respirations.

Design: We reviewed taped recordings of calls reporting cardiac arrests and emergency medical technician and paramedic incident reports for 1991. Arrests after arrival of emergency medical services were excluded.

Setting: King County, Washington, excluding the city of Seattle.

Participants: Four hundred forty-five persons with out-of-hospital cardiac arrests receiving emergency medical services.

Interventions: Telephone CPR, emergency medical technicians-defibrillation, and advanced life support by paramedics.

Measurements and main results: Any attempts at breathing described by callers were identified, as well as whether agonal respirations could be heard by dispatcher, emergency medical technicians, or paramedics. Agonal respirations occurred in 40% of 445 out-of-hospital cardiac arrests. Callers described agonal breathing in a variety of ways. Agonal respirations were present in 46% of arrests caused by cardiac etiology compared with 32% in other etiologies ($P < .01$). Fifty-five percent of witnessed arrests had agonal activity compared with 16% of unwitnessed arrests ($P < .001$). Agonal respirations occurred in 56% of arrests with a rhythm of ventricular fibrillation compared with 34% of cases with a nonventricular fibrillation rhythm ($P < .001$). Twenty-seven percent of patients with agonal respirations were discharged alive compared with 9% without them ($P < .001$).

Conclusion: There is a high incidence of agonal activity associated with out-of-hospital cardiac arrest. Presence of agonal respirations is associated with increased survival. These findings have implications for public CPR training programs and emergency dispatcher telephone CPR programs.

[Clark JJ, Larsen MP, Culley LL, Graves JR, Eisenberg MS: Incidence of agonal respirations in sudden cardiac arrest. *Ann Emerg Med* December 1991;21:1464-1467.]

Gasping during cardiac arrest

Mathias Zuercher[a] and Gordon A. Ewy[b,c]

[a]Department of Anaesthesia and Intensive Care, University Hospital, Basel, Switzerland, [b]University of Arizona Sarver Heart Center and [c]Department of Medicine, University of Arizona College of Medicine, Tucson, Arizona, USA

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Tel: +41 61 328 73 80; fax: +41 61 265 73 20; e-mail: mzuercher@uhbs.ch

Current Opinion in Critical Care 2009, 15:185–188

Purpose of review

The purpose of this study is to review the prevalence and significance of gasping in patients experiencing cardiac arrest.

Recent findings

In a recent study by Bobrow *et al.*, gasping was identified in 33% of patients who arrested after the arrival of emergency medical services (EMS). Patients who arrested previous to EMS arrival experienced a decreasing incidence of gasping with increasing duration of cardiac arrest: 20% if EMS arrived within 7 min, 14% if EMS arrival was between 7 and 9 min, and 7% if EMS arrived after 9 min. There was a positive association between the presence of gasping and survival: 28% of those who gasped survived compared with 8% of those who did not gasp (odds ratio, 3.4, 95% confidence interval, 2.2–5.2). Among the 481 patients who received bystander cardiopulmonary resuscitation, survival to hospital discharge occurred among 39% of patients who gasped versus 9% among those who did not gasp (adjusted odds ratio, 5.1, 95% confidence interval, 2.7–9.4).

Summary

Gasping frequently occurs during cardiac arrest. Public and emergency medical dispatchers must be more aware of its presence and significance.

Hyperventilation-Induced Hypotension During Cardiopulmonary Resuscitation

Tom P. Aufderheide, MD; Gardar Sigurdsson, MD; Ronald G. Pirrallo, MD, MHSA; Demetris Yannopoulos, MD; Scott McKnite, BA; Chris von Briesen, BA, EMT; Christopher W. Sparks, EMT; Craig J. Conrad, RN; Terry A. Provo, BA, EMT-P; Keith G. Lurie

TABLE 2. Animal Protocol I: Changes in Hemodynamics and Arterial Blood Gases With Three Different Ventilation Rates Delivered in Random Order (Mean±SEM)

	Ventilation Rate, Breaths per Minute			
	12	20	30	*P*
Hemodynamics				
SAP, mm Hg	68.8±4.7	62.7±4.2	60.1±3.6	0.33
CPP, mm Hg	23.4±1.0	19.5±1.8	16.9±1.8	0.03
MIP, mm Hg per minute	7.1±0.7	11.6±0.7	17.5±1.0	<0.0001
Arterial blood gases				
pH	7.34±0.02	7.45±0.03	7.52±0.03	0.0006
Pa_{CO_2}, mm Hg	22.7±2.7	15.6±2.2	11.6±1.5	0.005
Pa_{O_2}, mm Hg	340.9±40.7	403.3±47.0	403.7±48.0	0.59

SAP, Systolic aortic pressure; CPP, coronary perfusion pressure; MIP, mean intrathoracic pressure.

Statistical analysis was done by ANOVA. A value of $P<0.05$ was considered statistically significant.

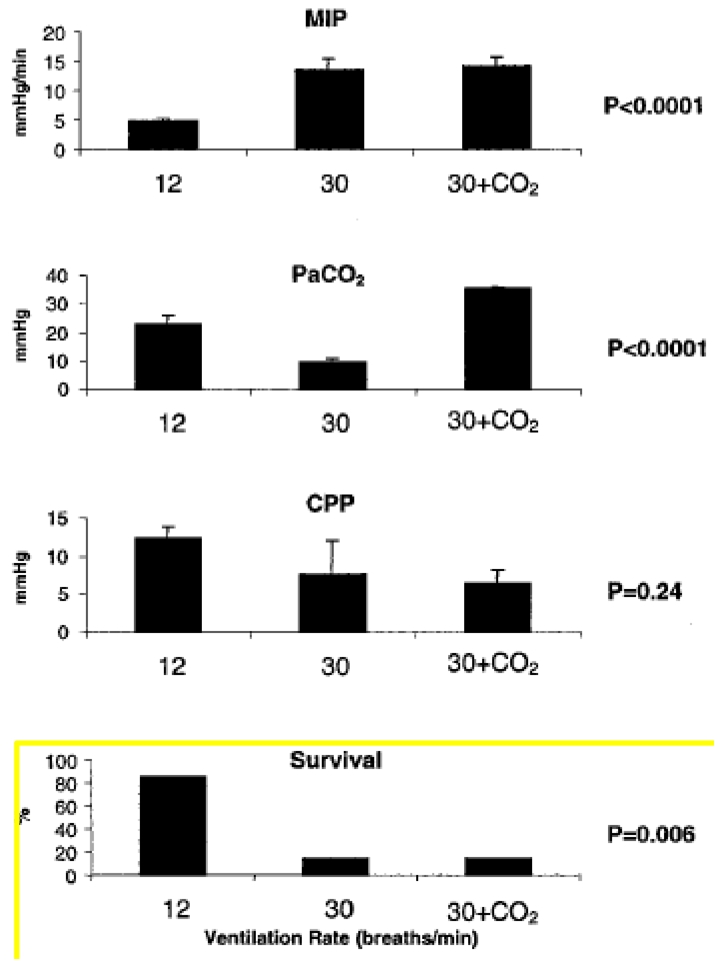


Figure 3. Survival Study (n=7 pigs per group). Changes in mean intrathoracic pressure (MIP), arterial CO_2 (Pa_{CO_2}), coronary perfusion pressure (CPP), and survival rate, with hyperventilation and correction of hypocapnia (+CO_2). Probability value of <0.05 was considered statistically significant, based on ANOVA analysis of the 3 groups.

Lancet. 2011 January 22; 377(9762): 301–311. doi:10.1016/S0140-6736(10)62103-4.

Comparative Effectiveness of Standard CPR versus Active Compression Decompression CPR with Augmentation of Negative Intrathoracic Pressure for Treatment of Out-of-Hospital Cardiac Arrest: Results from a Randomized Prospective Study

Tom P. Aufderheide, M.D.,

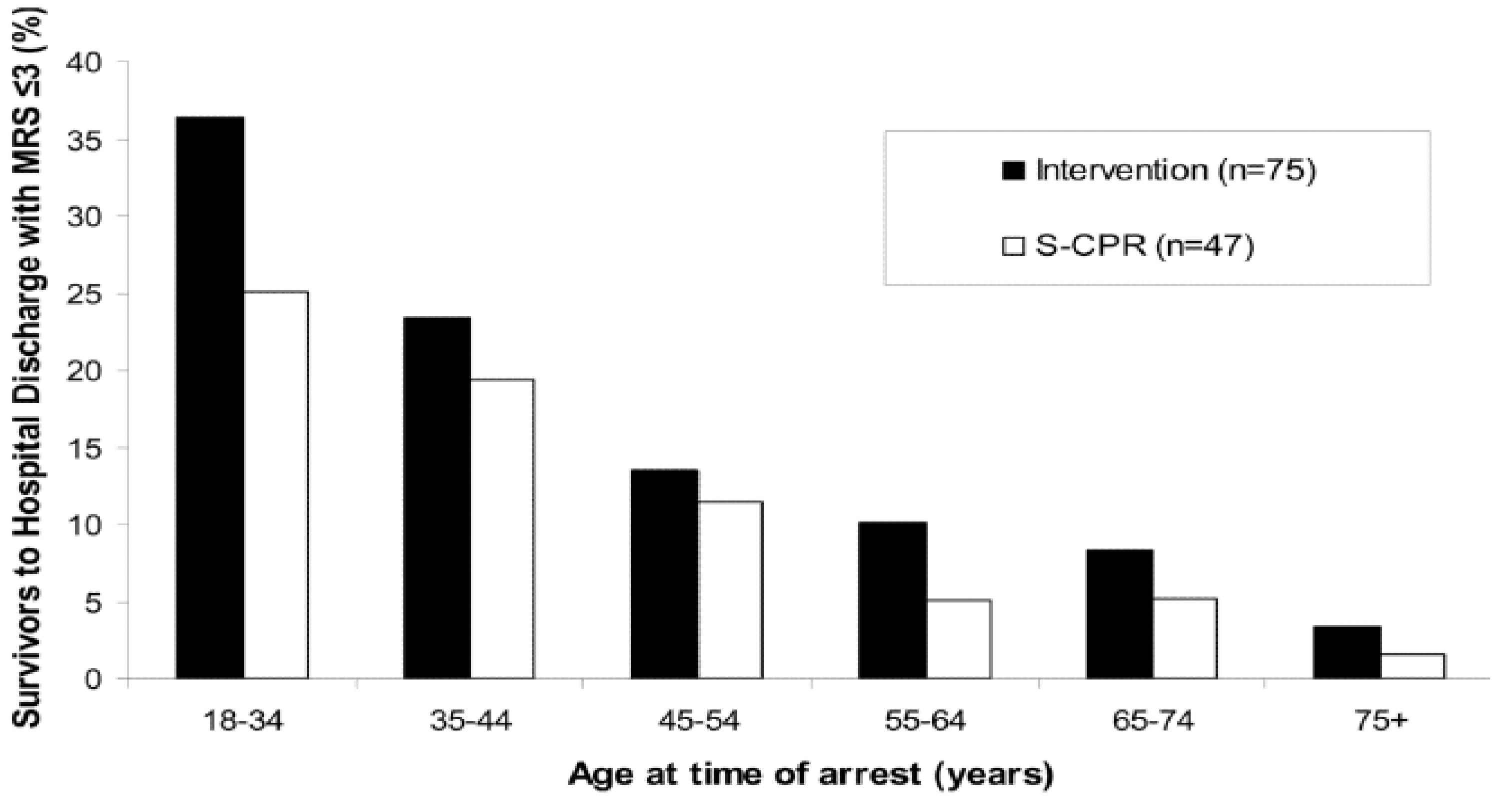
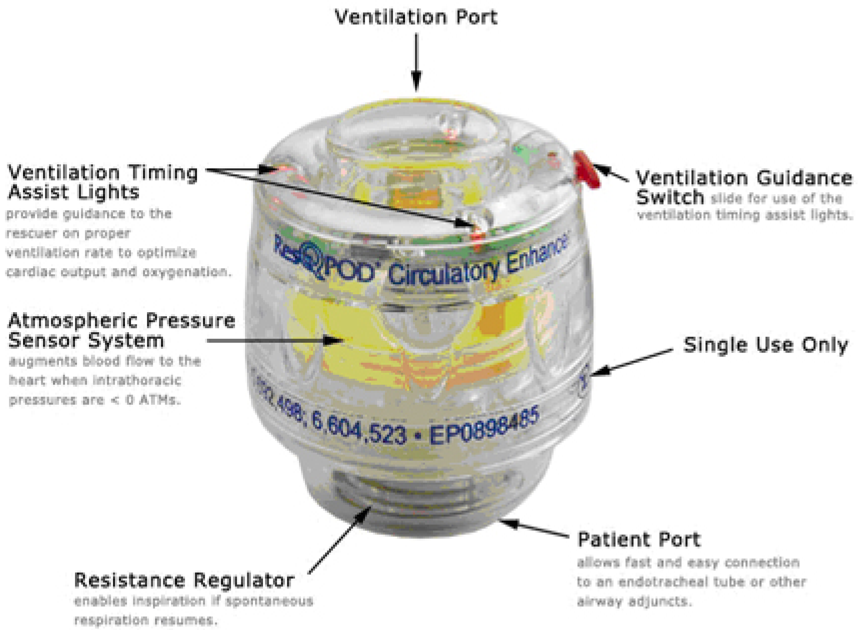
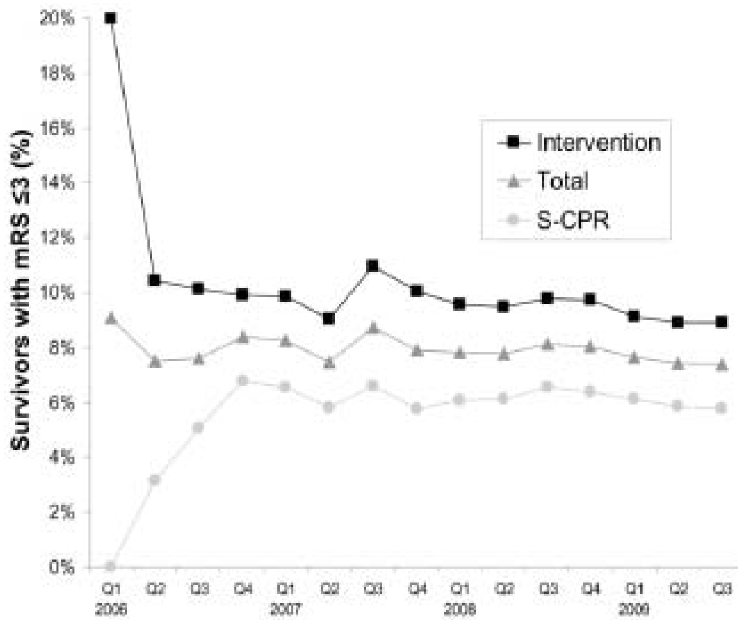


Figure 3.
Age Distribution of Patients Surviving to Hospital Discharge with a Favorable Neurologic Function. Results are shown as percent of patients/age group. Favorable Neurologic function was defined as MRS ≤ 3.


Ventilation Port
Ventilation Timing Assist Lights
provide guidance to the rescuer on proper ventilation rate to optimize cardiac output and oxygenation.
Ventilation Guidance Switch slide for use of the ventilation timing assist lights.
ResQPOD Circulatory Enhancer
Atmospheric Pressure Sensor System
augments blood flow to the heart when intrathoracic pressures are < 0 ATMs.
Single Use Only
6,604,523 • EP0898485
Resistance Regulator
enables inspiration if spontaneous respiration resumes.
Patient Port
allows fast and easy connection to an endotracheal tube or other airway adjuncts.



Intervention enrollment (cumulative)	5	172	387	713
S-CPR enrollment (cumulative)	6	168	395	703
Total enrollment (cumulative)	11	340	782	1416

Figure 5.

Cumulative Rates of Achieving the Primary Endpoint (mRS ≤3 at Hospital Discharge). Results are shown for pivotal phase enrollment (N=1653) by quarter. Consistent results in both groups were demonstrated throughout the entire duration of the study. Enrollment in Site 6 was initiated in the 4th Quarter (Q) of 2007 and in Site 7 in the 1st Quarter of 2009.

Use a ventilator?

- RR = 6 - 8
- VC – 400 - 500
- 100% FIO2 until ROSC
- Set Pressure alarm to 100
- Flow rate = 30 lpm

- emcrit

CIRCULATION

Review

Medical Principles and Practice

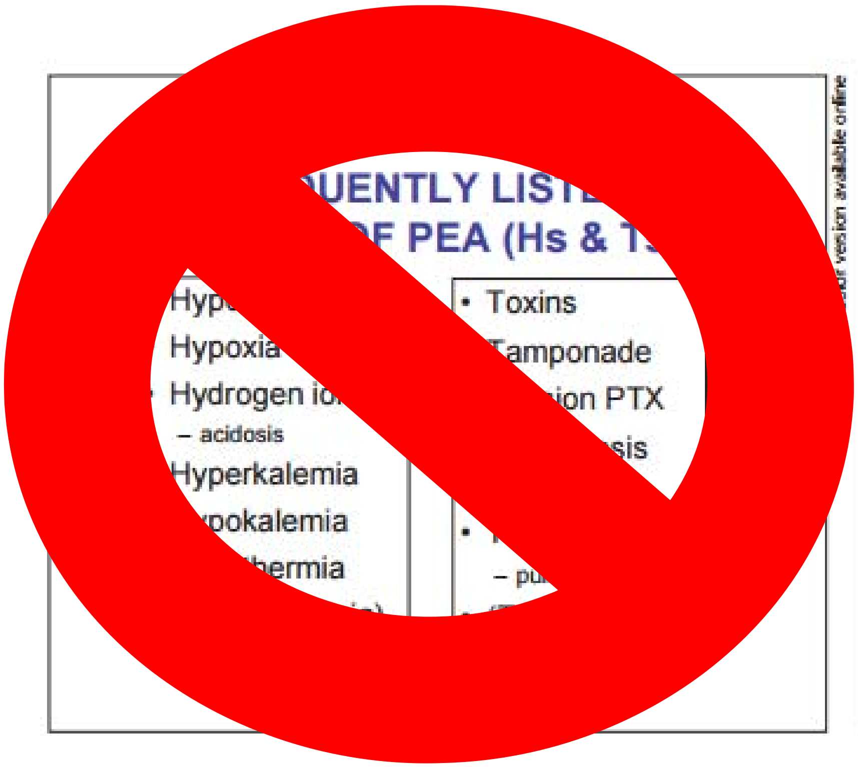
Med Princ Pract 2014;23:1–6
DOI: 10.1159/000354195

Received: February 27, 2013
Accepted: July 2, 2013
Published online: August 13, 2013

A Simplified and Structured Teaching Tool for the Evaluation and Management of Pulseless Electrical Activity

Laszlo Littmann[a] Devin J. Bustin[b] Michael W. Haley[a, c]

Departments of [a]Internal Medicine and [b]Emergency Medicine, and [c]Pulmonary and Critical Care Consultants, Carolinas Medical Center, Charlotte, N.C., USA



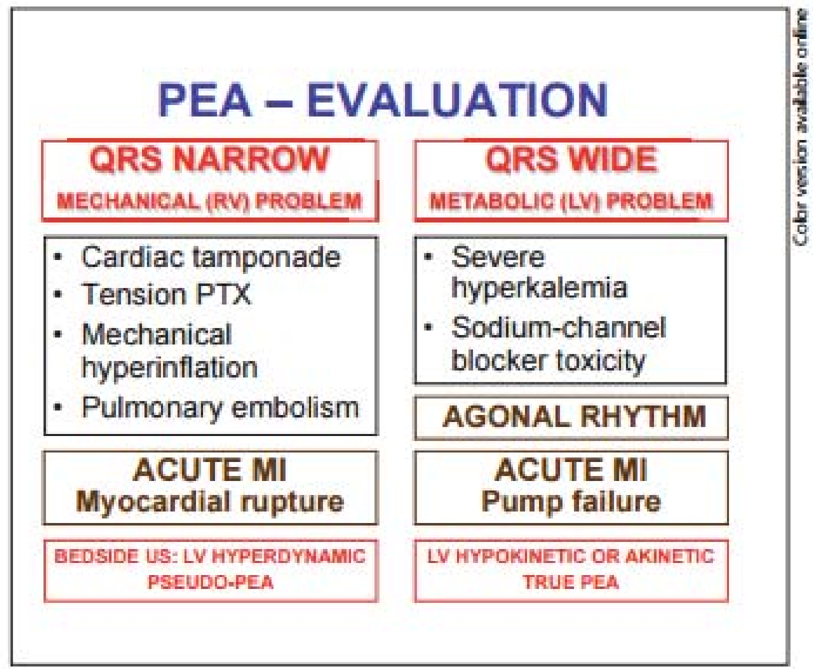


Fig. 1. Causes of PEA listed by European and American guidelines. Hypoglycemia and trauma have been removed from the most recent ACLS guidelines [6, 7]. PTX = Pneumothorax.

Fig. 2. New classification of PEA based on its initial electrocardiographic manifestation. LV = Left ventricular; PTX = pneumothorax; US = ultrasound; RV = right ventricular.

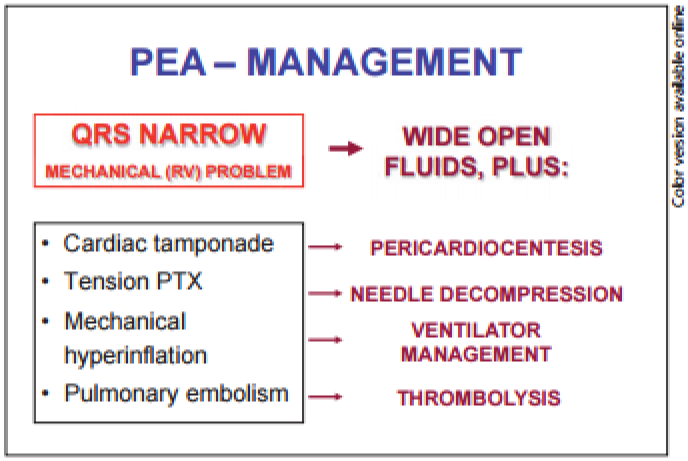


Fig. 3. Treatment recommendations for narrow-complex PEA. PTX = Pneumothorax: RV = right ventricular.

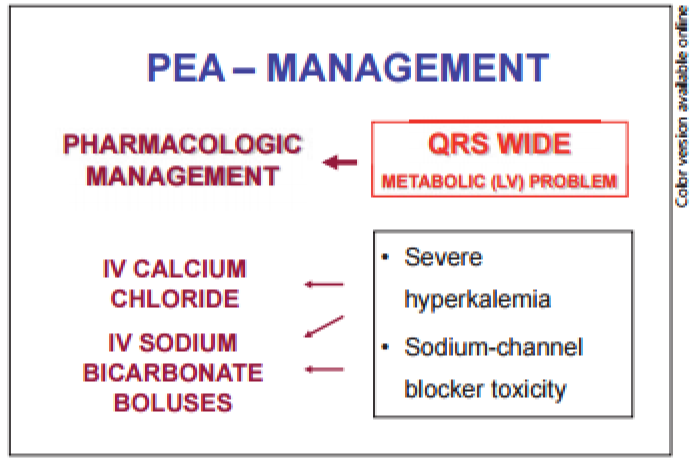


Fig. 4. Treatment recommendations for wide-complex PEA. IV = Intravenous; LV = left ventricular.

RUTGERS

Advanced Cardiac Arrest

Resuscitation 83 (2012) 1085–1089

Contents lists available at SciVerse ScienceDirect

Resuscitation

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

Clinical paper

Estimating the impact of off-balancing forces upon cardiopulmonary resuscitation during ambulance transport☆

Michael Christopher Kurz[a,*], Siddhartha A. Dante[b], Brian J. Puckett[b]

[a] Virginia Commonwealth University Reanimation Engineering Science (VCURES) Center and Department of Emergency Medicine, Virginia Commonwealth University Health System, Richmond, VA, United States
[b] School of Medicine, Virginia Commonwealth University, Richmond, VA, United States

M.C. Kurz et al. / Resuscitation 83 (2012) 1085–1089

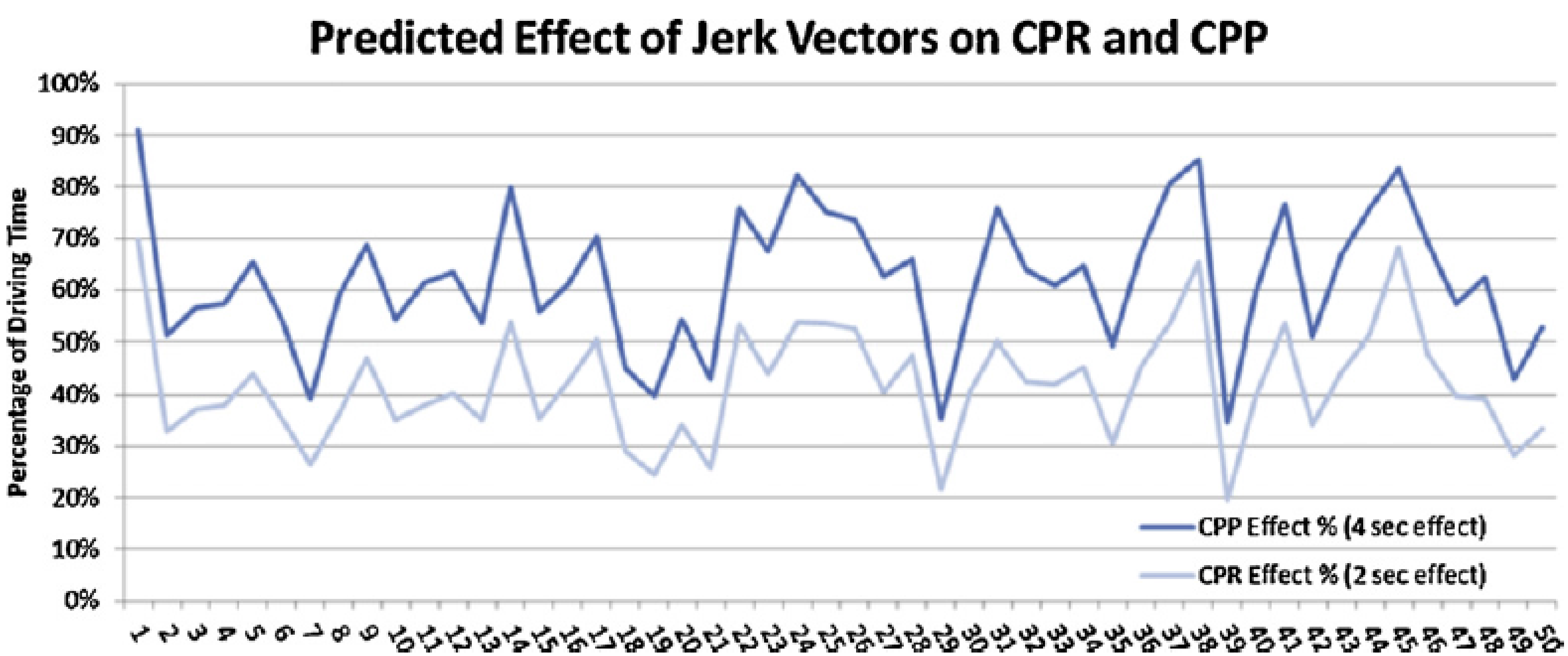


Fig. 2. Impact of Jerk vectors upon CPR and CPP utilizing the theoretical model.

MMI

Resuscitation (2008) 76, 185–190

available at www.sciencedirect.com

ScienceDirect

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

ELSEVIER

RESUSCITATION

CLINICAL PAPER

Quality of cardiopulmonary resuscitation before and during transport in out-of-hospital cardiac arrest☆

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[b] *The National Competence Centre for Emergency Medicine, Ulleval University Hospital, N-0407 Oslo, Norway*
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Received 30 March 2007; received in revised form 1 July 2007; accepted 7 July 2007

KEYWORDS
Advanced life support (ALS);
Cardiac arrest;
Chest compression;
Ambulance;
Out-of-hospital CPR;
Outcome;
Transthoracic impedance;
Transport

Summary
Aim of the study: To evaluate quality of cardiopulmonary resuscitation (CPR) performed during transport after out-of-hospital cardiac arrest.
Materials and methods: Retrospective, observational study of all non-traumatic cardiac arrest patients older than 18 years who received CPR both before and during transport between May 2003 and December 2006 from the community run EMS system in Oslo. Chest compressions and ventilations were detected from impedance changes in routinely collected ECG signals, and hands-off ratio calculated as time without chest compressions divided by total CPR time.
Results: Seventy-five of 787 consecutive out-of-hospital cardiac arrest patients met the inclusion criteria. Quality data were available from 36 of 66 patients receiving manual CPR and 7 of 9 receiving mechanical CPR. CPR was performed for mean 21 ± 11 min before and 12 ± 8 min during transport. With manual CPR hands-off ratio increased from 0.19 ± 0.09 on-scene to 0.27 ± 0.15 ($p = 0.002$) during transport. Compression and ventilation rates were unchanged causing a reduction in compressions per minute from $94 \pm 14\,\text{min}^{-1}$ to $82 \pm 19\,\text{min}^{-1}$ ($p = 0.001$). Quality was significantly better with mechanical than manual CPR. Four patients (5%) survived to hospital discharge: two with manual CPR (Cerebral performance categories (CPC) 1 and 2).

http://www.local1259iaff.org/motorcyclewreck5-31-02.htm

Resuscitation (2007) 74, 453—460

ELSEVIER

RESUSCITATION

www.elsevier.com/locate/resuscitation

CLINICAL PAPER

Video-recording and time-motion analyses of manual versus mechanical cardiopulmonary resuscitation during ambulance transport☆

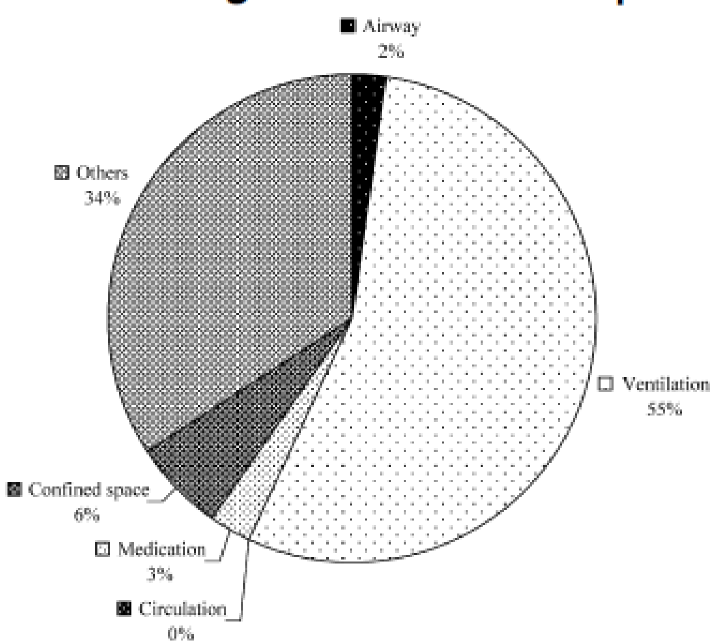
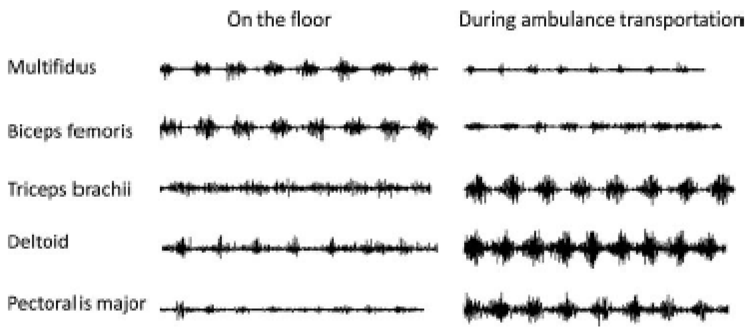


Figure 5 Causes of time lag from ambulance loading to first chest compression in the manual group.

Muscles Used for Chest Compression Under Static and Transportation Conditions

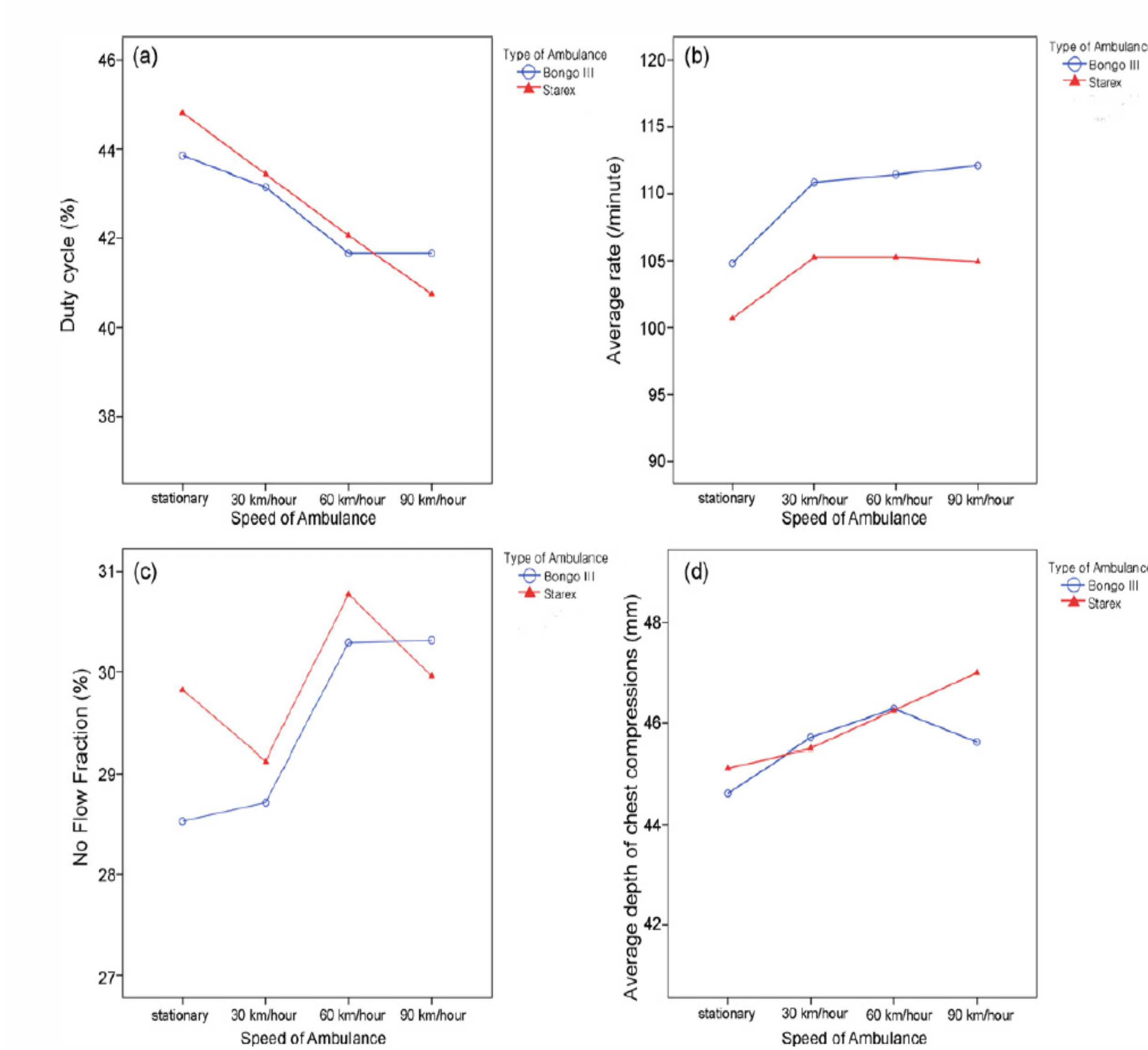
Yasuharu Yasuda, PhD, EMT-P, Yoshinori Kato, EMT-P, Katsuhiko Sugimoto, PhD, MD,
Shigeharu Tanaka, MS, Naoya Tsunoda, PhD, Daisuke Kumagawa, PhD,
Yoshiki Toyokuni, MS, Katsuaki Kubota, PhD, Hideo Inaba, PhD, MD



MM

Advanced Cardiac Arrest

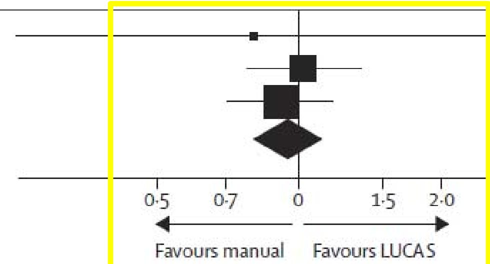
T.N. Chung et al. / Resuscitation 81 (2010) 841–847



A Survival to discharge or 30 days

	LUCAS Events	LUCAS Total	Manual Events	Manual Total	Weight	Year	Odds ratio M–H, fixed, 95% CI
Smekal 2011	6	75	7	72	2·7%	2011	0·81 (0·26–2·53)
LINC	112	1286	109	1275	41·6%	2013	1·02 (0·77–1·34)
PARAMEDIC	104	1652	193	2818	55·7%	2014	0·91 (0·71–1·17)
Total (95% CI)		**3013**		**4165**	**100·0%**		**0·96 (0·80–1·15)**
Total events	222		309				

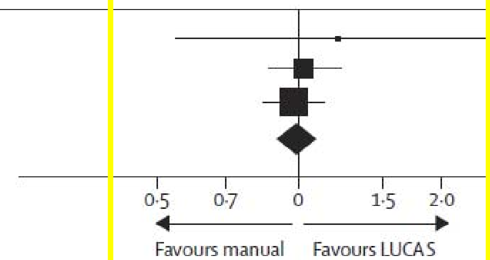
Heterogeneity: χ^2=0·43, df=2 (p=0·81); I^2=0%
Test for overall effect: Z=0·49 (p=0·62)



B Survived event

	LUCAS Events	LUCAS Total	Manual Events	Manual Total	Weight	Year	Odds ratio M–H, fixed, 95% CI
Smekal 2011	18	75	15	72	1·8%	2011	1·20 (0·55–2·61)
LINC	366	1300	357	1289	40·4%	2013	1·02 (0·86–1·21)
PARAMEDIC	377	1570	658	2690	57·8%	2014	0·98 (0·84–1·13)
Total (95% CI)		**2945**		**4051**	**100·0%**		**1·00 (0·90–1·11)**
Total events	761		1030				

Heterogeneity: χ^2=0·39, df=2 (p=0·82); I^2=0%
Test for overall effect: Z=0·02 (p=0·99)



C Survival with CPC 1–2

	LUCAS Events	LUCAS Total	Manual Events	Manual Total	Weight	Year	Odds ratio M–H, random, 95% CI
LINC	105	1286	94	1275	49·3%	2013	1·12 (0·84–1·49)
PARAMEDIC	77	1649	168	2815	50·7%	2014	0·77 (0·59–1·02)
Total (95% CI)		**2935**		**4090**	**100·0%**		**0·93 (0·64–1·33)**
Total events	182		262				

Heterogeneity: τ^2=0·05, χ^2=3·27, df=1 (p=0·07); I^2=69%
Test for overall effect: Z=0·42 (p=0·68)

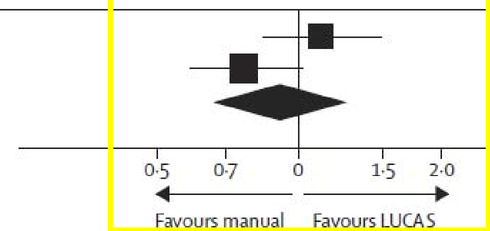


Figure 2: **Meta-analysis of the outcomes survived event and survival to hospital discharge or 30 days**
(A) Survival to discharge or 30 days. (B) Survived event. (C) Survival with CPC 1–2.

MMH/E

PARAMEDIC & LINC Trials

Mechanical CPR = Good Manual CPR

… when not in a moving ambulance

AHA Consensus Statement

Cardiopulmonary Resuscitation Quality: Improving Cardiac Resuscitation Outcomes Both Inside and Outside the Hospital

A Consensus Statement From the American Heart Association

Endorsed by the American College of Emergency Physicians and the Society of Critical Care Medicine

Peter A. Meaney, MD, MPH, Chair; Bentley J. Bobrow, MD, FAHA, Co-Chair;
Mary E. Mancini, RN, PhD, NE-BC, FAHA; Jim Christenson, MD; Allan R. de Caen, MD;
Farhan Bhanji, MD, MSc, FAHA; Benjamin S. Abella, MD, MPhil, FAHA;
Monica E. Kleinman, MD; Dana P. Edelson, MD, MS, FAHA; Robert A. Berg, MD, FAHA;
Tom P. Aufderheide, MD, FAHA; Venu Menon, MD, FAHA; Marion Leary, MSN, RN;
on behalf of the CPR Quality Summit Investigators, the American Heart Association Emergency
Cardiovascular Care Committee, and the Council on Cardiopulmonary, Critical Care,
Perioperative and Resuscitation

Abstract—The "2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care" increased the focus on methods to ensure that high-quality cardiopulmonary resuscitation (CPR) is

Table 2. Final Recommendations

1. High-quality CPR should be recognized as the foundation on which all other resuscitative efforts are built. Target CPR performance metrics include
   a. CCF >80%
   b. Compression rate of 100–120/min
   c. Compression depth of ≥50 mm in adults with no residual leaning
      i. (At least one third the anterior-posterior dimension of the chest in infants and children)
   d. Avoid excessive ventilation
      i. (Only minimal chest rise and a rate of <12 breaths/min)
2. At every cardiac arrest attended by professional rescuers
   a. Use at least 1 modality of monitoring the team's CPR performance
   b. Depending on available resources, use at least 1 modality of monitoring the patient's physiological response to resuscitative efforts
   c. Continually adjust resuscitative efforts based on the patient's physiological response
3. Resuscitation teams should coordinate efforts to optimize CPR during cardiac arrest by
   a. Starting compressions rapidly and optimizing CPR performance early
   b. Making sure that a team leader oversees the effort and delegates effectively to ensure rapid and optimal CPR performance
   c. Maintaining optimal CPR delivery while integrating advanced care and transport
4. Systems of care (EMS system, hospital, and other professional rescuer programs) should
   a. Determine a coordinated code team response with specific role responsibilities to ensure that high-quality CPR is delivered during the entire event
   b. Capture CPR performance data in every cardiac arrest and use an ongoing CPR CQI program to optimize future resuscitative efforts
   c. Implement strategies for continuous improvement in CPR quality and incorporate education, maintenance of competency, and review of arrest characteristics that include available CPR quality metrics
5. A national system for standardized reporting of CPR quality metrics should be developed:
   a. CPR quality metrics should be included and collected in national registries and databases for reviewing, reporting, and conducting research on resuscitation
   b. The AHA, appropriate government agencies, and device manufacturers should develop industry standards for interoperable raw data downloads and reporting from electronic data collected during resuscitation for both quality improvement and research

AHA indicates American Heart Association; CCF, chest compression fraction; CPR, cardiopulmonary resuscitation; CQI, continuous quality improvement; EMS, emergency medical services.

Further rec's

- ***Invasive Monitoring***
  - ***CPP >20 mm Hg***
- ***Arterial Line Only***
  - ***Arterial Diastolic Pressure >25 mm Hg***
- ***Capnography***
  - ***ETco2 >20 mm Hg***
  - ***ROSC = Sustained > 35 - 45***

Table 1. Compression Pause Requirements for Resuscitation Tasks

Pause Requirement	Task
Generally required	Defibrillation Rhythm analysis Rotation of compressors Backboard placement Transition to mechanical CPR or ECMO
Sometimes required	Complicated advanced airway placement in patients who cannot be ventilated effectively by bag-valve-mask Assessment for return of spontaneous circulation
Generally not required	Application of defibrillator pads Uncomplicated advanced airway placement IV/IO placement

CPR indicates cardiopulmonary resuscitation; ECMO, extracorporeal membrane oxygenation; and IV/IO, intravenous/intraosseous.

RUTGERS

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Resuscitation

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Clinical paper

The need to resume chest compressions immediately after defibrillation attempts: An analysis of post-shock rhythms and duration of pulselessness following out-of-hospital cardiac arrest☆

Ava E. Pierce*, Lynn P. Roppolo, Pamela Owens, Paul E. Pepe, Ahamed H. Idris

The Department of Emergency Medicine, University

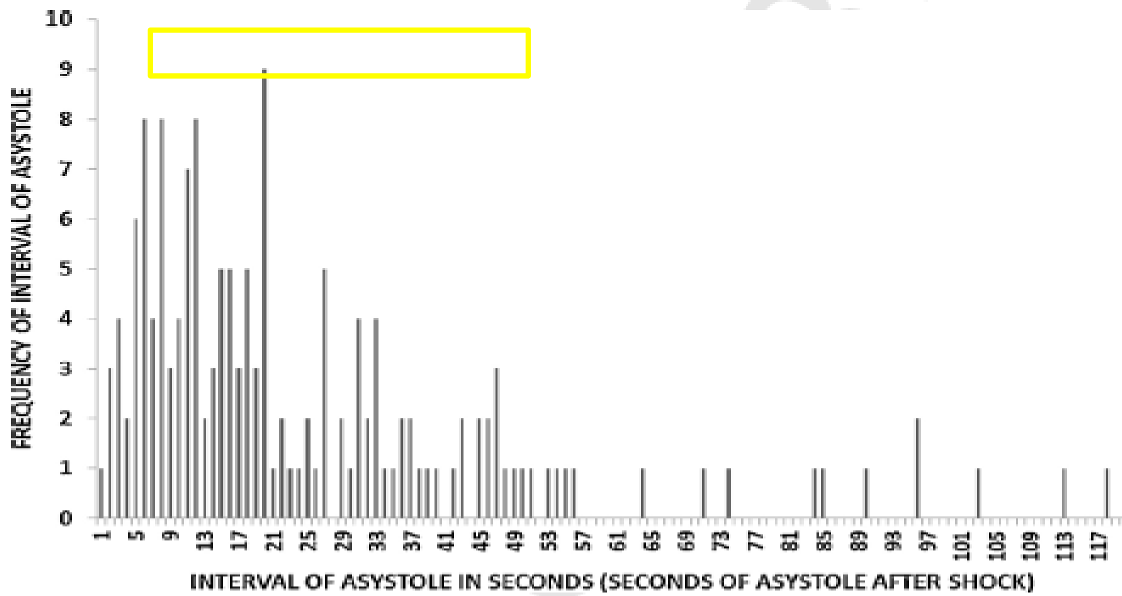


Fig. 3. Seconds of asystole (defined in the study as the interval of asystole) after 157 episodes of attempted defibrillation with the frequency that each interval of asystole occurred in this study. Twenty-five episodes of defibrillation had intervals of asystole between 128 and 1098 s (not depicted on the chart).

Adverse Hemodynamic Effects of Interrupting Chest Compressions for Rescue Breathing During Cardiopulmonary Resuscitation for Ventricular Fibrillation Cardiac Arrest

Robert A. Berg, MD; Arthur B. Sanders, MD; Karl B. Kern, MD; Ronald W. Hilwig, DVM, PhD; Joseph W. Heidenreich, BA; Matthew E. Porter, BA; Gordon A. Ewy, MD

Background—Despite improving arterial oxygen saturation and pH, bystander cardiopulmonary resuscitation (CPR) with chest compressions plus rescue breathing (CC+RB) has not improved survival from ventricular fibrillation (VF) compared with chest compressions alone (CC) in numerous animal models and 2 clinical investigations.

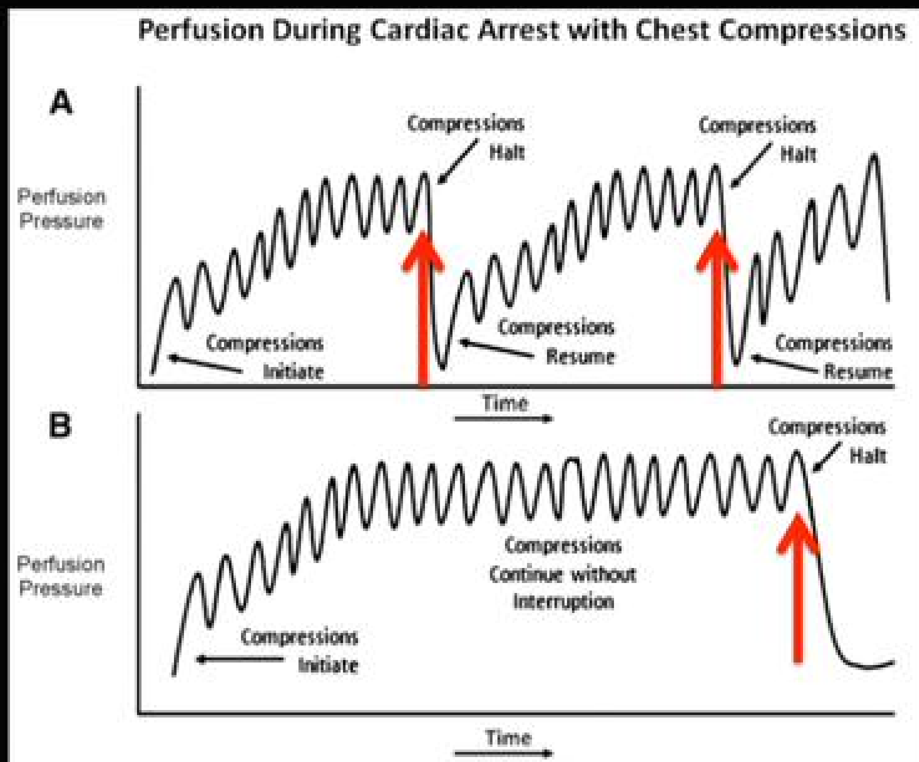
Methods and Results—After 3 minutes of untreated VF, 14 swine (32±1 kg) were randomly assigned to receive CC+RB or CC for 12 minutes, followed by advanced cardiac life support. All 14 animals survived 24 hours, 13 with good neurological outcome. For the CC+RB group, the aortic relaxation pressures routinely decreased during the 2 rescue breaths. Therefore, the mean coronary perfusion pressure of the first 2 compressions in each compression cycle was lower than those of the final 2 compressions (14±1 versus 21±2 mm Hg, $P<0.001$). During each minute of CPR, the number of chest compressions was also lower in the CC+RB group (62±1 versus 92±1 compressions, $P<0.001$). Consequently, the integrated coronary perfusion pressure was lower with CC+RB during each minute of CPR ($P<0.05$ for the first 8 minutes). Moreover, at 2 to 5 minutes of CPR, the median left ventricular blood flow by fluorescent microsphere technique was 60 mL · 100 g^{-1} · min^{-1} with CC+RB versus 96 mL · 100 g^{-1} · min^{-1} with CC, $P<0.05$. Because the arterial oxygen saturation was higher with CC+RB, the left ventricular myocardial oxygen delivery did not differ.

Conclusions—Interrupting chest compressions for rescue breathing can adversely affect hemodynamics during CPR for VF. (***Circulation*. 2001;104:2465-2470.**)

Key Words: cardiopulmonary resuscitation ■ heart arrest ■ hemodynamics ■ fibrillation ■ ventilation

***Circulation* November 13, 2001**

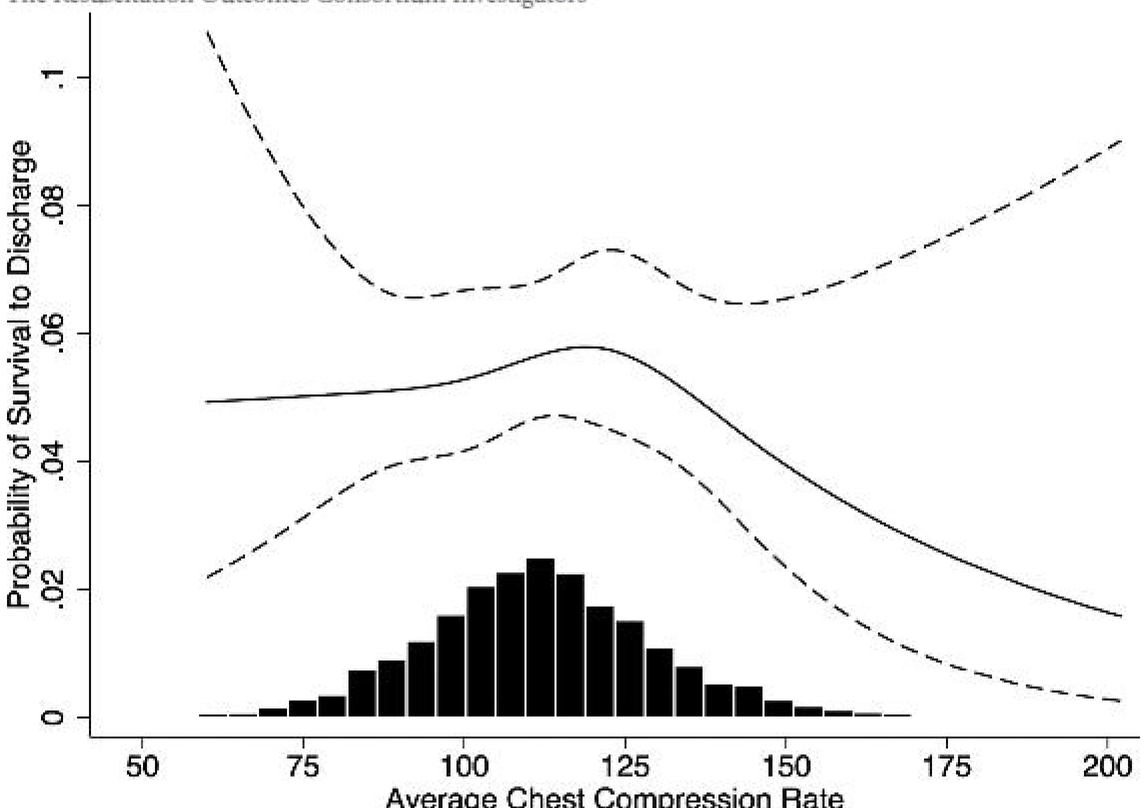
Coronary Perfusion is Dependent on Active CPR



Cunningham LM et al. American Journal of Emergency Medicine 2012

Chest Compression Rates and Survival Following Out-of-Hospital Cardiac Arrest

Ahamed H. Idris, MD[1]; Danielle Guffey, MS[2]; Paul P. Pepe, MD[3]; Siobhan P. Brown, PhD[2]; Steven C. Brooks, MD[4]; Clifton W. Callaway, MD, PhD[5]; Jim Christenson, MD[6]; Daniel P. Davis, MD[7]; Mohamud R. Daya, MD[8]; Randal Gray, BS, MA Ed, NREMT-P[9]; Peter J. Kudenchuk, MD[10]; Jonathan Larsen, EMT-P[11]; Steve Lin, MD[12]; James J. Menegazzi, PhD[5]; Kellie Sheehan, BSN[2]; George Sopko, MD, MPH[13]; Ian Stiell, MD, MSc[14]; Graham Nichol, MD[15]; Tom P. Aufderheide, MD[16]; for The Resuscitation Outcomes Consortium Investigators



Circulation.2012; 125: 3004-3012

rates between 100 and 120/min during cardiopulmonary resuscitation for out-of-hospital cardiac arrest. However, the relationship between compression rate and survival is still undetermined.

Design: Prospective, observational study.

Setting: Data is from the Resuscitation Outcomes Consortium Prehospital Resuscitation IMpedance threshold device and Early versus Delayed analysis clinical trial.

Participants: Adults with out-of-hospital cardiac arrest treated by emergency medical service providers.

Interventions: None.

Measurements Main Results: Data were abstracted from monitor-defibrillator recordings for the first five minutes of emergency medical service cardiopulmonary resuscitation. Multiple logistic regression assessed odds ratio for survival by compression rate categories (<80, 80–99, 100–119, 120–139, ≥140), both unadjusted and adjusted for sex, age, witnessed status, attempted bystander cardiopulmonary resuscitation, location of arrest, chest compression fraction and depth, first rhythm, and study site. Compression rate data were available for 10,371 patients; 6,399 also had chest compression fraction and depth data. Age (mean ± SD) was 67±16 years. Chest compression rate was 111±19 per minute, compression fraction was 0.70±0.17, and compression depth was 42±12 mm. Circulation was restored in 34%; 9% survived to hospital discharge. After adjustment for covariates without chest compression depth and fraction ($n = 10{,}371$), a global test found no significant relationship between compression rate and survival ($p = 0.19$). However, after adjustment for covariates including chest compression depth and fraction ($n = 6{,}399$), the global test found a significant relationship between compression rate and survival ($p = 0.02$), with the reference group (100–119 compressions/min) having the greatest likelihood for survival.

Conclusions: After adjustment for chest compression fraction and depth, compression rates between 100 and 120 per minute were associated with greatest survival to hospital discharge. (*Crit Care Med* 2014; XX:00–00)

Key Words: cardiac arrest; cardiopulmonary resuscitation; compression rate; guidelines; heart arrest; outcomes

Adverse Outcomes of Interrupted Precordial Compression During Automated Defibrillation

Ting Yu, MD; Max Harry Weil, MD, PhD; Wanchun Tang, MD; Shijie Sun, MD; Kada Klouche, MD; Heitor Povoas, MD; Joe Bisera, MSEE

Background—Current versions of automated external defibrillators (AEDs) require frequent stopping of chest compression for rhythm analyses and capacity charging. The present study was undertaken to evaluate the effects of these interruptions during the operation of AEDs.

Methods and Results—Ventricular fibrillation was electrically induced in 20 male domestic swine weighing between 37.5 and 43 kg that were untreated for 7 minutes before CPR was started. Defibrillation was attempted with up to 3 sequential 150-J biphasic shocks, but each was preceded by 3-, 10-, 15-, or 20-second interruptions of chest compression. The interruptions corresponded to those that were mandated by commercially marketed AEDs for rhythm analyses and capacitor charge. The sequence of up to 3 electrical shocks and delays were repeated at 1-minute intervals until the animals were successfully resuscitated or for a total of 15 minutes. Spontaneous circulation was restored in each of 5 animals in which precordial compression was delayed for 3 seconds before the delivery of the first and subsequent shocks but in none of the animals in which the delay was >15 seconds before the delivery of the first and subsequent shocks. Longer intervals of CPR interventions were required, and there was correspondingly greater failure of resuscitation in close relationship to increasing delays. The durations of interruptions were inversely related to the durations of subthreshold levels of coronary perfusion pressure. Postresuscitation arterial pressure and left ventricular ejection fraction were more severely impaired with increasing delays.

Conclusions—Interruptions of precordial compression for rhythm analyses that exceed 15 seconds before each shock compromise the outcome of CPR and increase the severity of postresuscitation myocardial dysfunction. (*Circulation*. 2002;106:368-372.)

Key Words: cardiopulmonary resuscitation ■ fibrillation ■ defibrillation ■ compression ■ myocardium

Clinical Investigation

Coronary Perfusion Pressure and the Return of Spontaneous Circulation in Human Cardiopulmonary Resuscitation

Norman A. Paradis, MD; Gerard B. Martin, MD; Emanuel P. Rivers, MD; Mark G. Goetting, MD; Timothy J. Appleton; Marcia Feingold, PhD; Richard M. Nowak, MD

Survival From Prolonged Cardiac Arrest Relates to the Coronary Perfusion Pressures Generated During Chest Compression

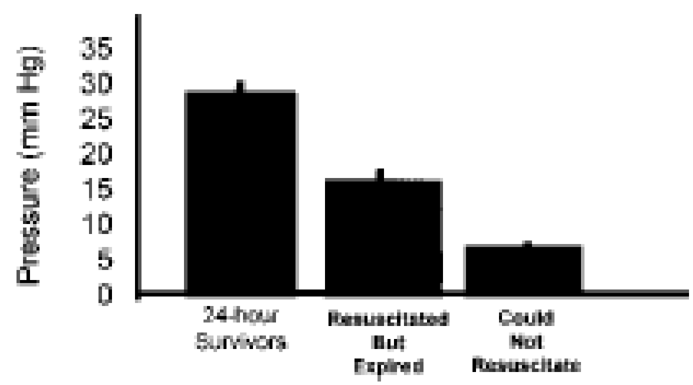


Figure 2. Survival from prolonged cardiac arrest in canines relates to coronary perfusion pressure generated during external chest compressions. See text.

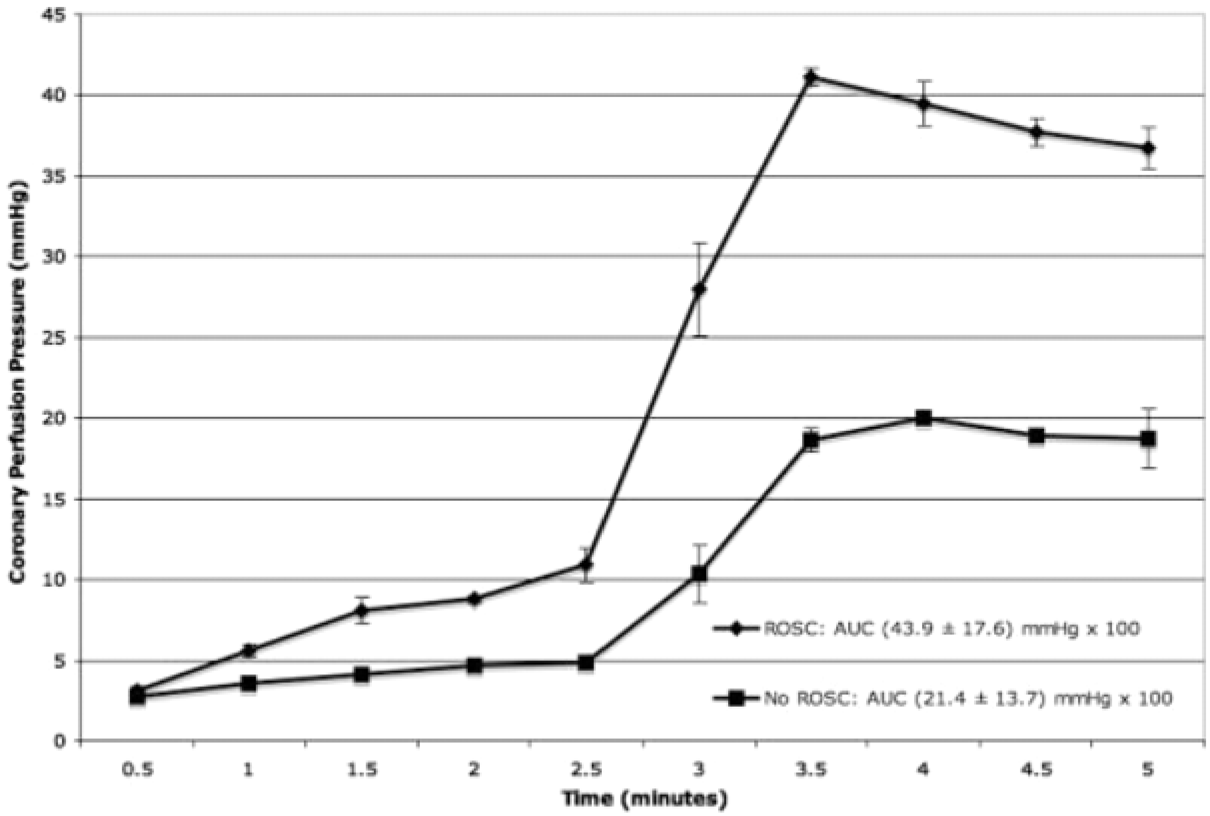
Resuscitation Science Symposium

Abstract P115: Higher Threshold and Dose of Coronary Perfusion Pressure are Associated with ROSC in Prolonged Swine Cardiac Arrest

Circulation. 2008;118:S_1470

Joshua C Reynolds ; David D Salcido ; James J Menegazzi

Univ of Pittsburgh, Pittsburgh, PA



Published in final edited form as:
Resuscitation. 2014 August ; 85(8): 983–986. doi:10.1016/j.resuscitation.2014.04.015.

Hemodynamic–directed cardiopulmonary resuscitation during in–hospital cardiac arrest*

Robert M. Sutton[a], **Stuart H. Friess**[b], **Matthew R. Maltese**[a], **Maryam Y. Naim**[a], **George Bratinov**[a], **Theodore R. Weiland**[a], **Mia Garuccio**[a], **Utpal Bhalala**[c], **Vinay M. Nadkarni**[a], **Lance B. Becker**[d], and **Robert A. Berg**[a,*]

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[b]St. Louis Children's Hospital, Washington University in St. Louis School of Medicine, Department of Pediatrics, 660 South Euclid Avenue, St. Louis, MO 63110, United States

[c]Bloomberg Children's Center, Johns Hopkins Hospital, Johns Hopkins University School of Medicine, Department of Anesthesiology and Critical Care Medicine, 1800 Orleans Street, Baltimore, MD 21287, United States

[d]The Hospital of the University of Pennsylvania, University of Pennsylvania Perelman School of Medicine, Department of Emergency Medicine, 3400 Spruce Street, Philadelphia, PA 19104, United States

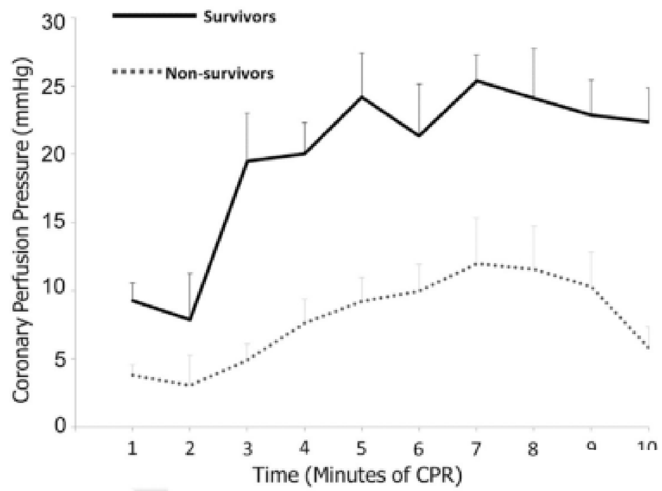

Fig. 1.
Mean coronary perfusion pressure during each minute of CPR between survivors after hypoxic ventricular fibrillation. Similar results were alsc VF model.[10] Error bars represent SEM. Modified from Sutton et al.,[9] R

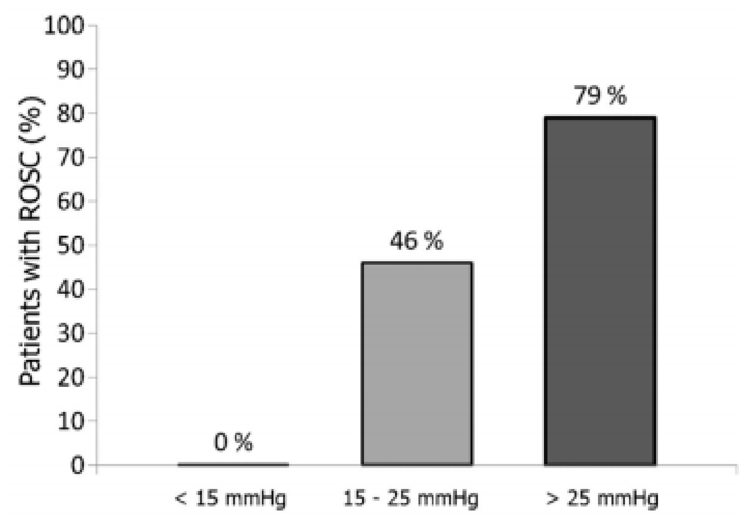

Fig. 2.
Percentage of patients achieving return of spontaneous circulation (ROSC) during adult cardiac arrest resuscitation. Modified from Paradis et al.,[12] Journal of the American Medical Association 1990.

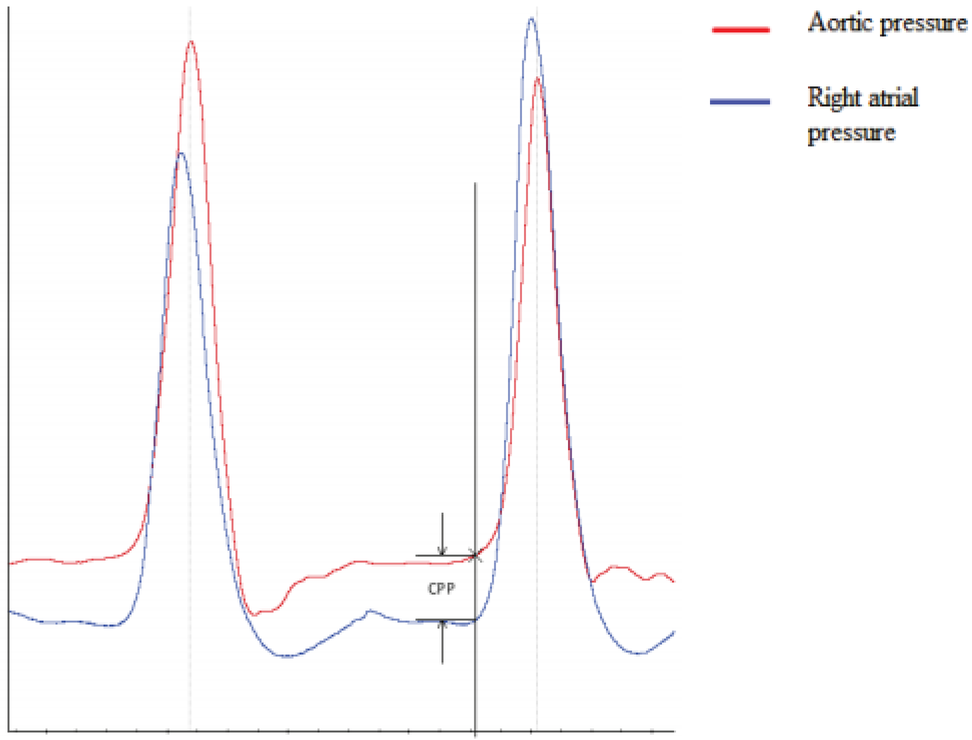

Figure 1. Identifying a common point on pressure waveforms: the "end-diastolic" method

http://cdn.adinstruments.com/adi-web/software-tips/Calculating-Coronary-Perfusion-Pressure-using-LabChart-Macros.pdf

Resuscitation 85 (2014) 1298–1303

Contents lists available at ScienceDirect

Resuscitation

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Experimental paper

Hemodynamic directed CPR improves cerebral perfusion pressure and brain tissue oxygenation[☆,☆☆]

Stuart H. Friess[a,*], Robert M. Sutton[b], Benjamin French[c], Utpal Bhalala[d], Matthew R. Maltese[b], Maryam Y. Naim[b], Georg
Silvana Arciniegas Rodriguez[b], Theodore R. We
Vinay M. Nadkarni[b], Lance B. Becker[e], Robert A

A B S T R A C T

Aim: Advances in cardiopulmonary resuscitation (CPR) have focused on the generation and maintenance of adequate myocardial blood flow to optimize the return of spontaneous circulation and survival. Much of the morbidity associated with cardiac arrest survivors can be attributed to global brain hypoxic ischemic injury. The objective of this study was to compare cerebral physiological variables using a hemodynamic directed resuscitation strategy versus an absolute depth-guided approach in a porcine model of ventricular fibrillation (VF) cardiac arrest.

Methods: Intracranial pressure and brain tissue oxygen tension probes were placed in the frontal cortex prior to induction of VF in 21 female 3-month-old swine. After 7 min of VF, animals were randomized to receive one of three resuscitation strategies: (1) hemodynamic directed care (CPP-20): chest compressions (CCs) with depth titrated to a target systolic blood pressure of 100 mmHg and titration of vasopressors to maintain coronary perfusion pressure (CPP) >20 mmHg; (2) depth 33 mm (D33): target CC depth of 33 mm with standard American Heart Association (AHA) epinephrine dosing; or (3) depth 51 mm (D51): target CC depth of 51 mm with standard AHA epinephrine dosing.

Results: Cerebral perfusion pressures (CerePP) were significantly higher in the CPP-20 group compared to both D33 ($p < 0.01$) and D51 ($p = 0.046$), and higher in survivors compared to non-survivors irrespective of treatment group ($p < 0.01$). Brain tissue oxygen tension was also higher in the CPP-20 group compared to both D33 ($p < 0.01$) and D51 ($p = 0.013$), and higher in survivors compared to non-survivors irrespective of treatment group ($p < 0.01$). Subjects with a CPP >20 mmHg were 2.7 times more likely to have a CerePP >30 mmHg ($p < 0.001$).

Conclusions: Hemodynamic directed resuscitation strategy targeting coronary perfusion pressure >20 mmHg following VF arrest was associated with higher cerebral perfusion pressures and brain tissue oxygen tensions during CPR.

Neurologic Critical Care

Arterial Blood Pressure and Neurologic Outcome After Resuscitation From Cardiac Arrest*

J. Hope Kilgannon, MD[1]; Brian W. Roberts, MD[1]; Alan E. Jones, MD[2]; Neil Mittal, MD[1]; Evan Cohen, MD[1]; Jessica Mitchell, MD[1,3]; Michael E. Chansky, MD[1]; Stephen Trzeciak, MD, MPH[1,3]

Objectives: Guidelines for post–cardiac arrest care recommend blood pressure optimization as one component of neuroprotection. Although some retrospective clinical studies suggest that postresuscitation hypotension may be harmful, and laboratory studies suggest that a postresuscitation hypertensive surge may be protective, empirical data are few. In this study, we prospectively measured blood pressure over time during the postresuscitation period and tested its association with neurologic outcome.

Design: Single center, prospective observational study from 2009 to 2012.

Patients: Inclusion criteria were age 18 years old or older, prearrest independent functional status, resuscitation from cardiac arrest, and comatose immediately after resuscitation.

Measurements and Main Results: Our research protocol measured blood pressure noninvasively every 15 minutes for the first 6 hours after resuscitation. We calculated the 0- to 6-hour time-weighted average mean arterial pressure and used multivariable logistic regression to test the ass time-weighted average mean arteri rologic outcome, defined as Cerebr or 2 at hospital discharge. Among 1 rienced good neurologic outcome blood pressure and outcome ap effect at time-weighted average mean arterial pressure value of 70 mm Hg. This threshold (mean arterial pressure > 70 mm Hg) had the strongest association with good neurologic outcome (odds ratio, 4.11; 95% CI, 1.34–12.66; $p = 0.014$). A sustained intrinsic hypertensive surge was relatively uncommon and was not associated with neurologic outcome.

Conclusions: We found that time-weighted average mean arterial pressure was associated with good neurologic outcome at a threshold of mean arterial pressure greater than 70 mm Hg. (*Crit Care Med* 2014; 42:2083–2091)

Key Words: brain injury; cardiopulmonary resuscitation; ischemia-reperfusion injury; return of spontaneous circulation

The post–cardiac arrest syndrome is a state of severe, global ischemia/reperfusion injury with potentially

(*Crit Care Med* 2014; 42:2083–2091)

ORIGINAL ARTICLE

Patient-Centric Blood Pressure–targeted Cardiopulmonary Resuscitation Improves Survival from Cardiac Arrest

Robert M. Sutton[1], Stuart H. Friess[2], Maryam Y. Naim[1], Joshua W. Lampe[3], George Bratinov[1], Theodore R. Weiland III[1], Mia Garuccio[1], Vinay M. Nadkarni[1], Lance B. Becker[3], and Robert A. Berg[1]

[1]Department of Anesthesiology and Critical Care Medicine, The Children's Hospital of Philadelphia, and [3]Department of Emergency Medicine, The Hospital of the University of Pennsylvania, University of Pennsylvania Perelman School of Medicine, Philadelphia, Pennsylvania; and [2]Department of Pediatrics, St. Louis Children's Hospital, Washington University in St. Louis School of Medicine, St. Louis, Missouri

EMERGENCY MEDICAL SERVICES/ORIGINAL RESEARCH

Cardiocerebral Resuscitation Improves Neurologically Intact Survival of Patients With Out-of-Hospital Cardiac Arrest

Michael J. Kellum, MD
Kevin W. Kennedy, MS
Richard Barney, MD
Franz A. Keilhauer, MD
Michael Bellino, MD
Mathias Zuercher, MD
Gordon A. Ewy, MD

From the Departments of Emergency Medicine at Mercy Health System, Janesville, WI (Kellum, Kennedy, Keilhauer); Beloit Memorial Hospital, Beloit, WI (Barney); Aurora Lakeland Medical Center, Elkhorn, WI (Bellino); University of Arizona Sarver Heart Center, University of Arizona College of Medicine, Tucson, AZ (Zuercher, Ewy); and University of Basel, Basel, Switzerland (Zuercher).

Study objective: In an effort to improve neurologically normal survival of victims of cardiac arrest, a new out-of-hospital protocol was implemented by the emergency medical system medical directors in 2 south-central rural Wisconsin counties. The project was undertaken because the existing guidelines for care of such patients, despite their international scope and periodic updates, had not substantially improved survival rates for such patients during nearly 4 decades.

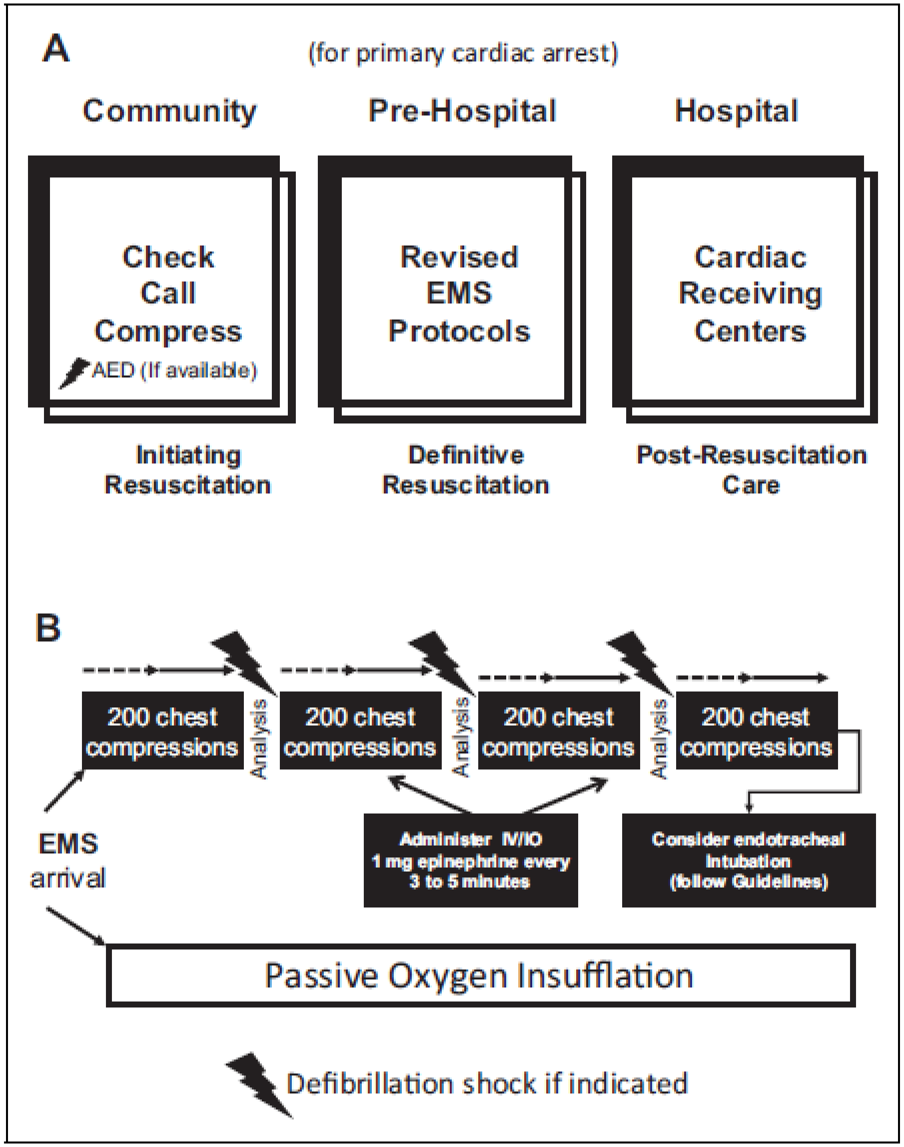
Methods: The neurologic status at or shortly after discharge was documented for adult patients with a witnessed collapse and an initially shockable rhythm. Patients during two 3-year periods were compared. During the 2001 through 2003 period, in which the 2000 American Heart Association guidelines were used, data were collected retrospectively. During the mid-2004 through mid-2007 period, patients were treated according to the principles of cardiocerebral resuscitation. Data for these patients were collected prospectively. Cerebral performance category scores were used to define the neurologic status of survivors, and a score of 1 was considered as "intact" survival.

Results: In the 3 years preceding the change in protocol, there were 92 witnessed arrests with an initially shockable rhythm. Eighteen patients survived (20%) and 14 (15%) were neurologically intact. During the 3 years after implementation of the new protocol, there were 89 such patients. Forty-two (47%) survived and 35 (39%) were neurologically intact.

Conclusion: In adult patients with a witnessed cardiac arrest and an initially shockable rhythm, implementation of an out-of-hospital treatment protocol based on the principles of cardiocerebral resuscitation was associated with a dramatic improvement in neurologically intact survival. [Ann Emerg Med. 2008;52:244-252.]

0196-0644/$-see front matter

doi:10.1016/j.annemergmed.2008.02.006

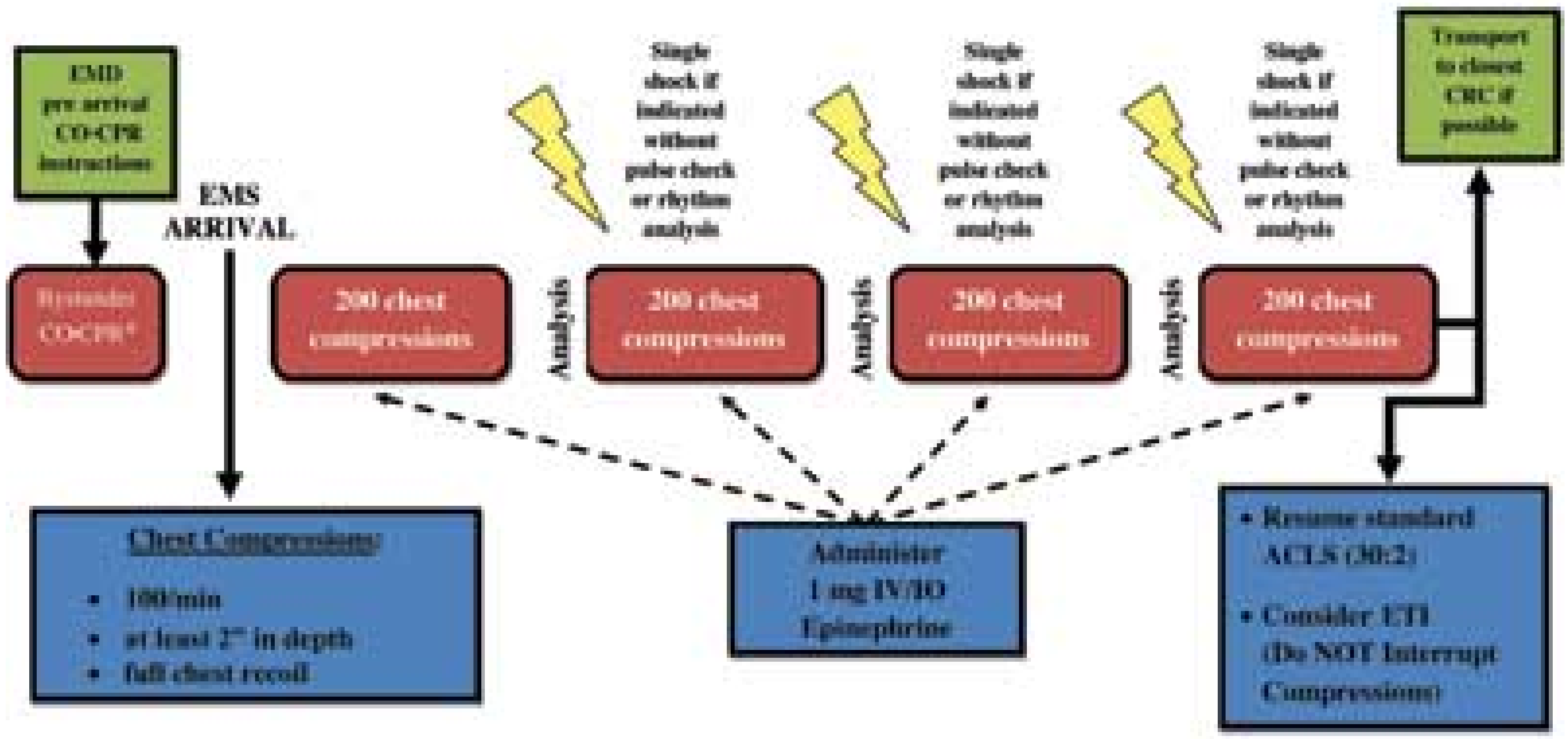


Cardiocerebral Resuscitation: An Approach to Improving Survival of Patients With Primary Cardiac Arrest
Gordon A. Ewy MD1 and Bentley J. Bobrow, MD2,3

Journal of Intensive Care Medicine
1-10

DOI: 10.1177/0885066614544450

(aka Minimally Interrupted Cardiac Resuscitation)



*If adequate uninterrupted bystander chest compressions are provided, EMS providers perform immediate rhythm analysis.

CO-CPR=compression-only CPR CRC=cardiac receiving center EMD=emergency medical dispatch

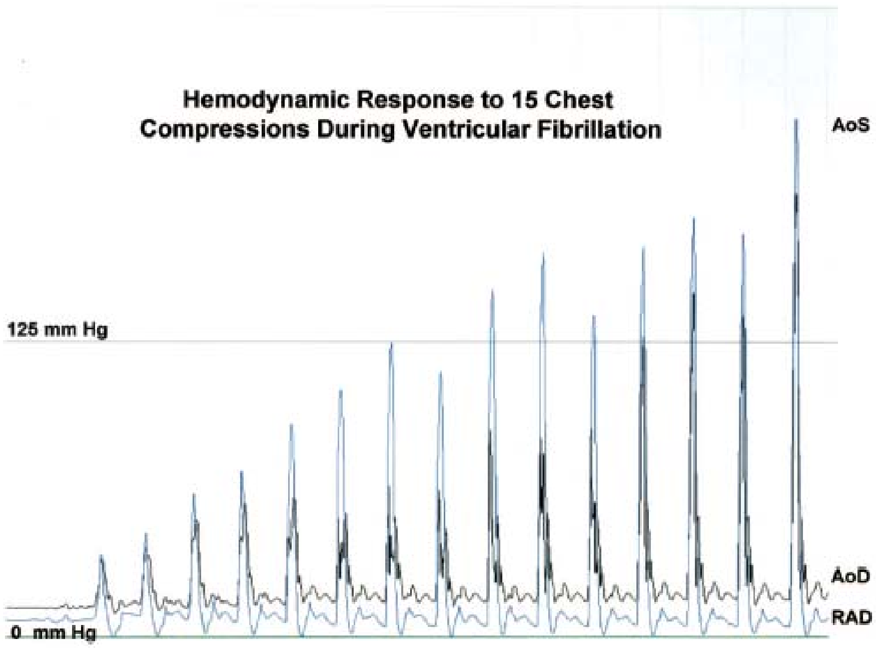


Figure 1. Simultaneous recording of aortic and right atrial pressures during first 15 external chest compressions in swine in cardiac arrest due to ventricular fibrillation. AoS indicates aortic "systolic" pressure during chest compression; AoD, aortic "diastolic" pressure during release phase; and RAD, right atrial pressure during "diastolic" or release phase of chest compression.

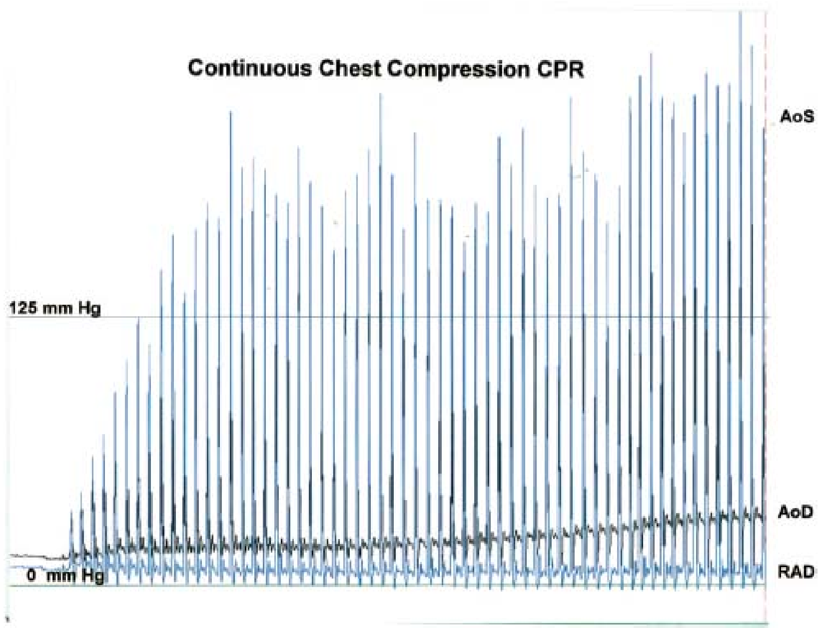


Figure 3. Simultaneous recording of aortic and right atrial pressures during continuous external chest compressions in swine in cardiac arrest due to ventricular fibrillation. AoS indicates aortic "systolic" pressure during chest compression; AoD, aortic "diastolic" pressure during release phase; and RAD, right atrial pressure during "diastolic" or release phase of chest compression.

CARDIOLOGY/ORIGINAL RESEARCH

Precountershock Cardiopulmonary Resuscitation Improves Ventricular Fibrillation Median Frequency and Myocardial Readiness for Successful Defibrillation From Prolonged Ventricular Fibrillation: A Randomized, Controlled Swine Study

Robert Allen Berg, MD
Ronald Willard Hilwig, DVM

See related article, p. 553, and editorial, p. 571.

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Resuscitation

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RESUSCITATION

Clinical paper

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

CrossMark

Sheldon Cheskes[a,*], Robert H. Schmicker[b], P. Richard Verbeek[a], David D. Salcido[d], Siobhan P. Brown[b], Steven Brooks[f], James J. Menegazzi[d], Christian Vaillancourt[e], Judy Powell[b], Susanne May[b], Robert A. Berg[g], R Terri Schmidt[i], Jim Christenson[c], Resuscitation investigators

A B S T R A C T

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 during the ROC PRIMED randomized controlled trial.

Methods: We included patients in the ROC PRIMED trial who suffered OHCA between June 2007 and November 2009, presented with a shockable rhythm and had CPR process data for at least one shock. We used multivariable logistic regression to determine the association between peri-shock pause duration and survival to hospital discharge.

Results: Among 2006 patients studied, the median (IQR) shock pause duration was: pre-shock pause 15 s (8, 22); post-shock pause 6 s (4, 9); and peri-shock pause 22.0 s (14, 31). After adjusting for Utstein predictors of survival as well as CPR quality measures, the odds of survival to hospital discharge were significantly higher for patients with pre-shock pause <10 s (OR: 1.52, 95% CI: 1.09, 2.11) and peri-shock pause <20 s (OR: 1.82, 95% CI: 1.17, 2.85) when compared to patients with pre-shock pause ≥20 s and peri-shock pause ≥40 s. Post-shock pause was not significantly associated with survival to hospital discharge. Results for neurologically intact survival (Modified Rankin Score ≤ 3) were similar to our primary outcome.

Conclusions: In patients with cardiac arrest presenting in a shockable rhythm during the ROC PRIMED trial, shorter pre- and peri-shock pauses were significantly associated with higher odds of survival. Future cardiopulmonary education and technology should focus on minimizing all peri-shock pauses.

S. Cheskes et al. / Resuscitation 85 (2014) 336–342

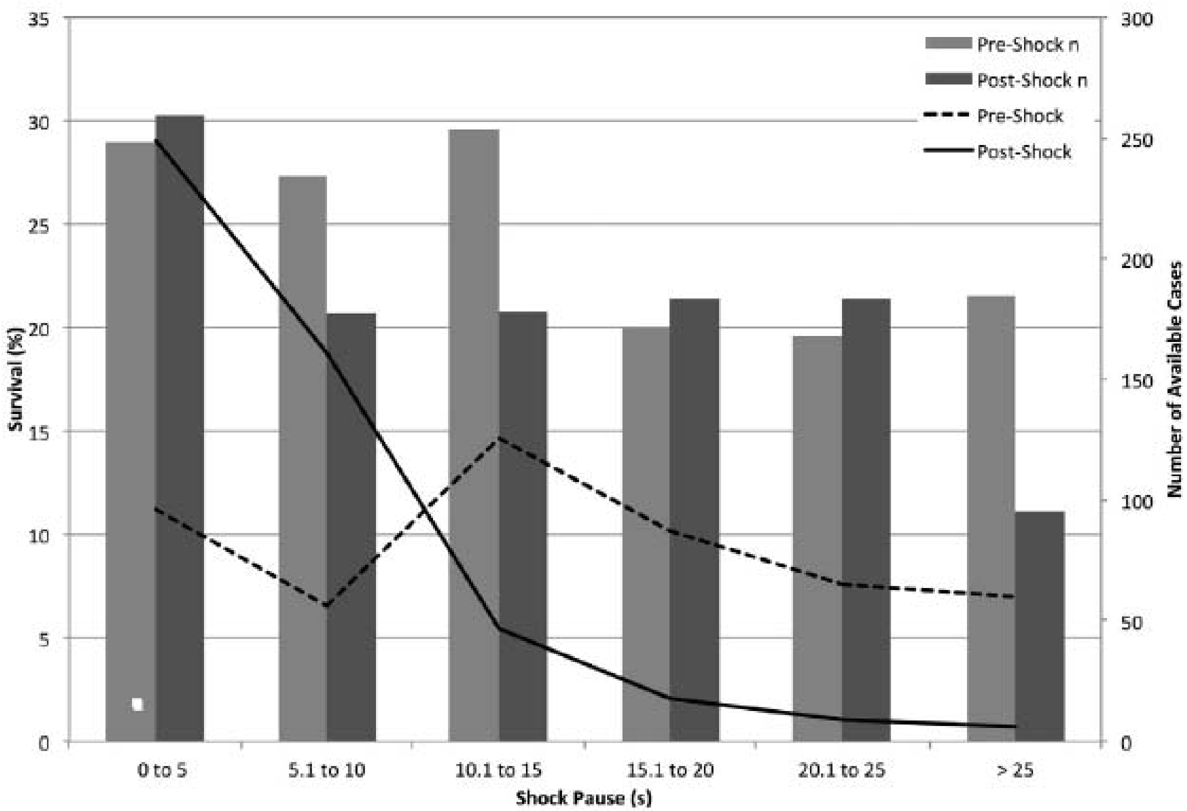
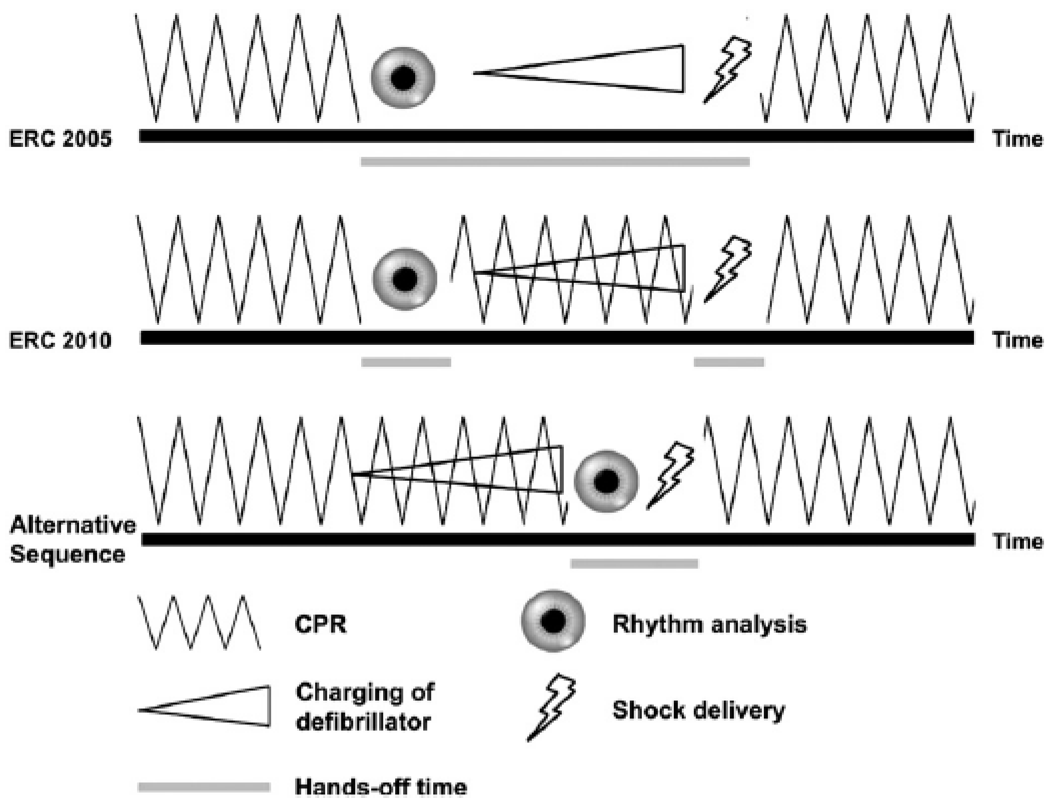


Fig. 2. Plot of unadjusted survival to hospital discharge versus median shock pause interval. Survival results are shown as column plots referring to the left-side axis, categorized into 5 shock pause interval ranges, and stratified by pre-shock and post-shock pause classification. Counts of available cases for each survival estimate are shown for each shock pause interval range as line plots referring to the right-side axis.

Brief Report

Defibrillator charging before rhythm analysis significantly reduces hands-off time during resuscitation: a simulation study☆,☆☆

Lars Koch Hansen MD[a,*], Lars Folkestad MD[b], Mikkel Brabrand MD[c]



Contents lists available at ScienceDirect

Resuscitation

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

Simulation and education

Rhythm analysis and charging during chest compressions reduces compression pause time☆

R. Partridge[a,*], Q. Tan[b], A. Silver[b], M. Riley[b], F. Geheb[b], R. Raymond[c]

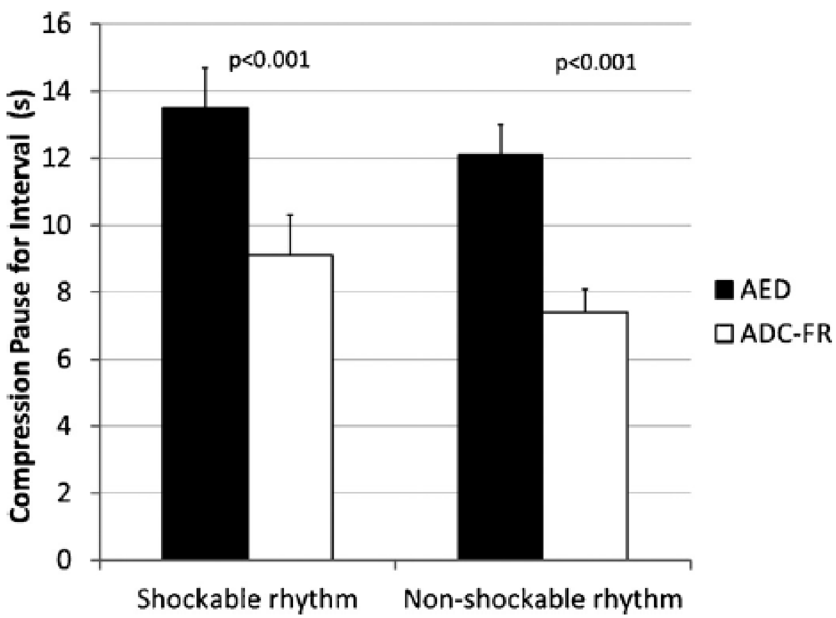


Fig. 4. For both shockable and non-shockable rhythm intervals, chest compression interruptions were significantly shorter with ADC-FR vs. AED defibrillator operation.

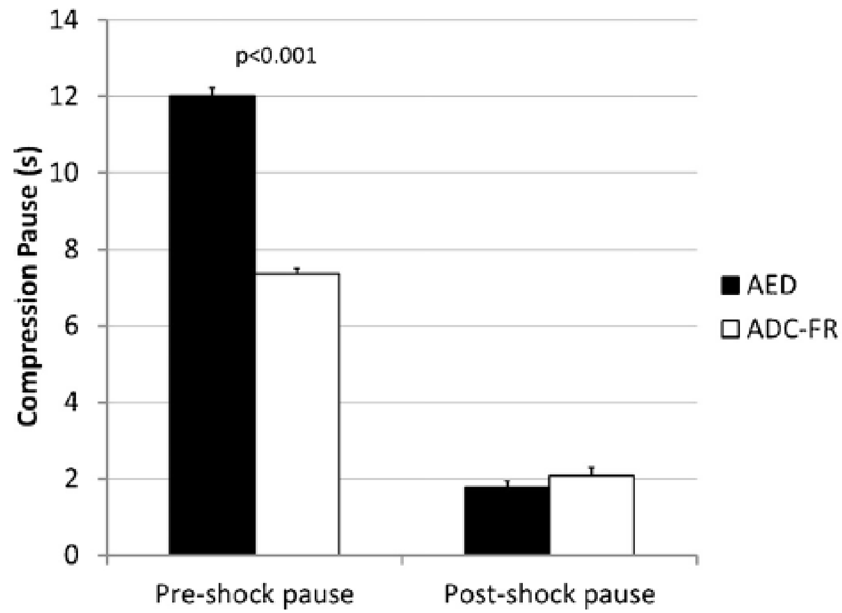


Fig. 5. Shockable rhythms: pre-shock pause was significantly shortened during intervals with ADC-FR compared with AED whereas post-shock pause was unchanged.

RUTGERS

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Advanced Cardiac Life Support in Out-of-Hospital Cardiac Arrest

Ian G. Stiell, M.D., George A. Wells, Ph.D., Brian Field, A.C.P., M.B.A., Daniel W. Spaite, M.D., Lisa P. Nesbitt, M.H.A., Valerie J. De Maio, M.D., Graham Nichol, M.D., M.P.H., Donna Cousineau, B.Sc.N., Josée Blackburn, B.Sc., Doug Munkley, M.D., Lorraine Luinstra-Toohey, B.Sc.N., M.H.A., Tony Campeau, M.Ed., Eugene Dagnone, M.D., and Marion Lyver, M.D., for the Ontario Prehospital Advanced Life Support Study Group

ABSTRACT

BACKGROUND

The Ontario Prehospital Advanced Life Support (OPALS) Study tested the incremental

From the


CONCLUSIONS

Advanced Cardiac Arrest

Research

Original Investigation

Outc... ...ted

b...

...Joseph P. Newhouse, PhD; Alan M. Zaslavsky, ...

...rests receiving emergency medical services in ...ce providers trained in advanced life support ...r basic life support (BLS) is limited.

...TIVE To compa... ...es after out-of-hospital cardiac ...t.

...SIGN, SETTING, AND PARTICIPAN... ...nally ...presentative sample of traditional M... ...ties who ...perienced out-of-hospital cardiac arrest ... 2011, ...d for whom ALS or BLS ambulance services w... ...and ...3 BLS cases). Propensity score methods were u... ...LS ...atient survival, neurological performance, and med...

...TCOMES AND MEASURES Survival to hospital discharge, ...al performance; and incremental medical spending per ad...

...l to hospital discharge was greater among patients receiving ...% CI, 2.3-5.7] percentage point difference), was survival ... [95% CI, 1.2-4.0] percentage point difference). Basic life su... ...al functioning among hospitalized patients (21...

CONCLUSIONS AND RELEVAN... ...cardiac arrest who received BLS had higher survival at hospital discharge and at 90 days compared with those who received ALS and were less likely to experience poor neurological functioning.


CARING FOR THE CRITICALLY ILL PATIENT

Prehos... Pati... of-Hospital C...

...t Epinephrine is widely used in cardiopulmonary re... ...diac arrest (OHCA). However, the effectiveness of epi... ...has not been established.

...uate the association between epinephrine use befor... ...-term mortality in patients with cardiac arrest.

...icipants Prospective, nonrandomized, observati... ...188 OHCAs occurring in 2005-2008 in Japan ... OHCA before arrival of emergency medica... (EM... ...ersonnel, and were transported to the h...

Main O... ...ontaneous circulation before hosp... rival, surviv... ...rvival with good or moderate c... performance (C... ...1 or 2), and survival with n... or moderate neuro... ...ce Category [OPC] 1 ...

Results Return of spo... ...rrival was observe... of 15 030 patients (18.5%) i... ...402 158 patie... in the no-epinephrine group (P... ...) and 1... of 13 401 propensity-matched pa... numbers of patients with 1-month su... respectively, were 805 (5.4%), 205 (1.4%)... (4.7%), 8903 (2.2%), and 8831 (2.2%) with... ing numbers in propensity-matched patients were ... with epinephrine and 944 (7.0%), 413 (3.1%), and... ...). In all patients, a positive associati... ...ve ...n con- ...ospital epi- ...ival, 0.46 [95% ...0.32 [95% CI, 0.27- ...erved among propensity- ...54 [95% CI, 0.43-0.68]; CPC 1-2, 0.21 [95% CI, ... 1-2, 0.23 [95% CI, 0.11-0.45]; all P<.001).

Conclusion Among patients with OHCA in Japan, use of prehospital epinephrine was significantly associated with increased chance of return of spontaneous circulation before hospital arrival but decreased chance of survival and good functional out-

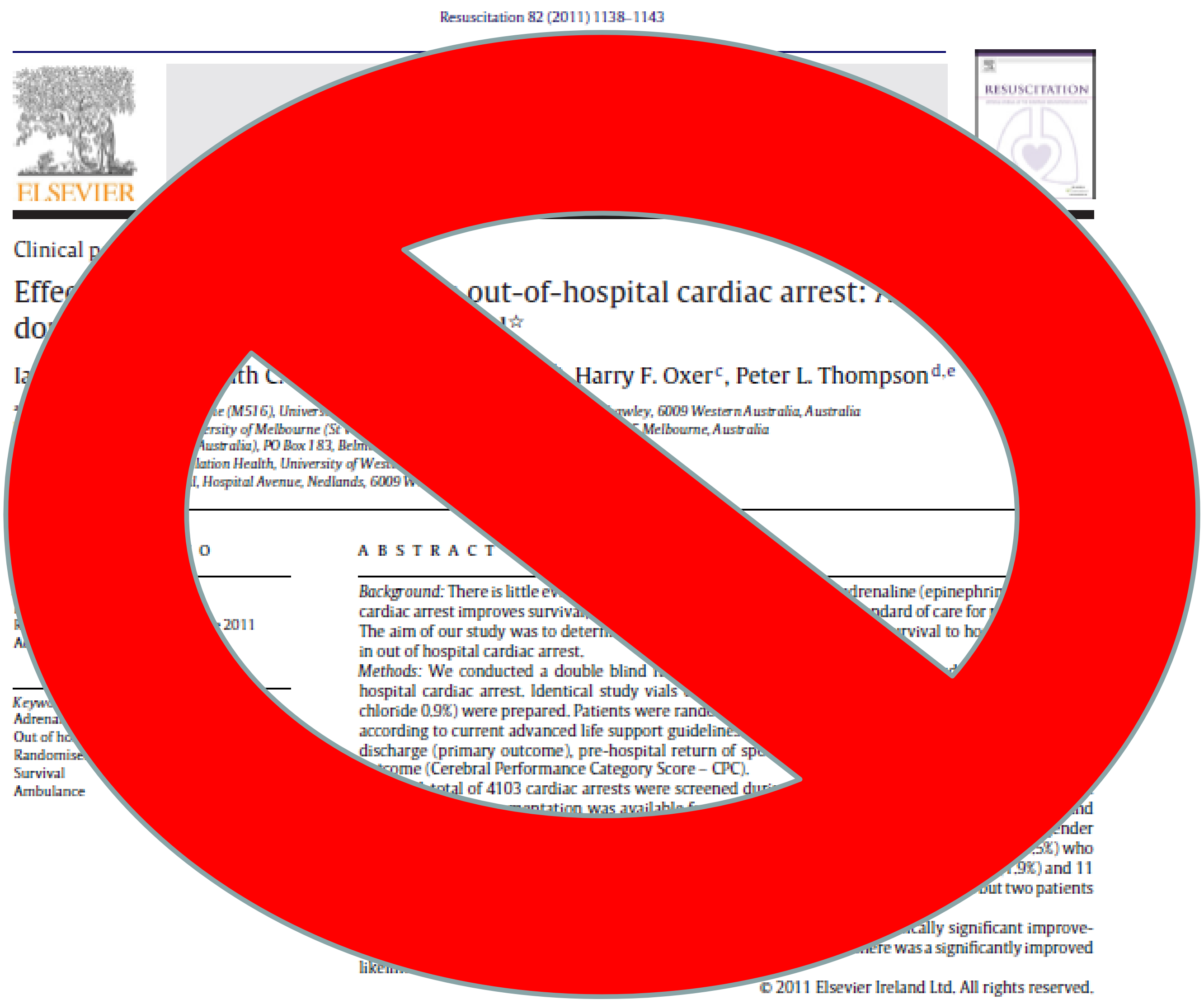
Aki... M...

...MD

...hD

...NE IS WIDELY USED IN ...lmonary resuscita- ...R) for patients with ...spital cardiac arrest ...ver, its effectiveness ...n established. Epi- ...ted with increased ...nsumption and ...as during the ...n.[4] Concern ...ncreased ...d dis- h... my... turb... after ca... port of ep... mal studies... short-term effe... and evidence of in... and coronary perfusion ... peripheral blood flow ha... reported.[10,11]

To verify the effectiveness of epinephrine in CPR, the influences of other factors, such as patients, bystanders, CPR by bystanders, life support by



Resuscitation 82 (2011) 1138–1143

ELSEVIER

RESUSCITATION

Clinical p

Effec out-of-hospital cardiac arrest: A
do l☆

Ia th C Harry F. Oxer[c], Peter L. Thompson[d,e]

e (M516), Univers wley, 6009 Western Australia, Australia
ersity of Melbourne (St Melbourne, Australia
Australia), PO Box 183, Belm
lation Health, University of West
l, Hospital Avenue, Nedlands, 6009 W

O

2011

Keyw
Adrena
Out of ho
Randomise
Survival
Ambulance

A B S T R A C T

Background: There is little ev drenaline (epinephrin
cardiac arrest improves surviva ndard of care for
The aim of our study was to deter rvival to ho
in out of hospital cardiac arrest.
Methods: We conducted a double blind
hospital cardiac arrest. Identical study vials
chloride 0.9%) were prepared. Patients were rand
according to current advanced life support guideline
discharge (primary outcome), pre-hospital return of sp
tcome (Cerebral Performance Category Score – CPC).
total of 4103 cardiac arrests were screened duri
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ender
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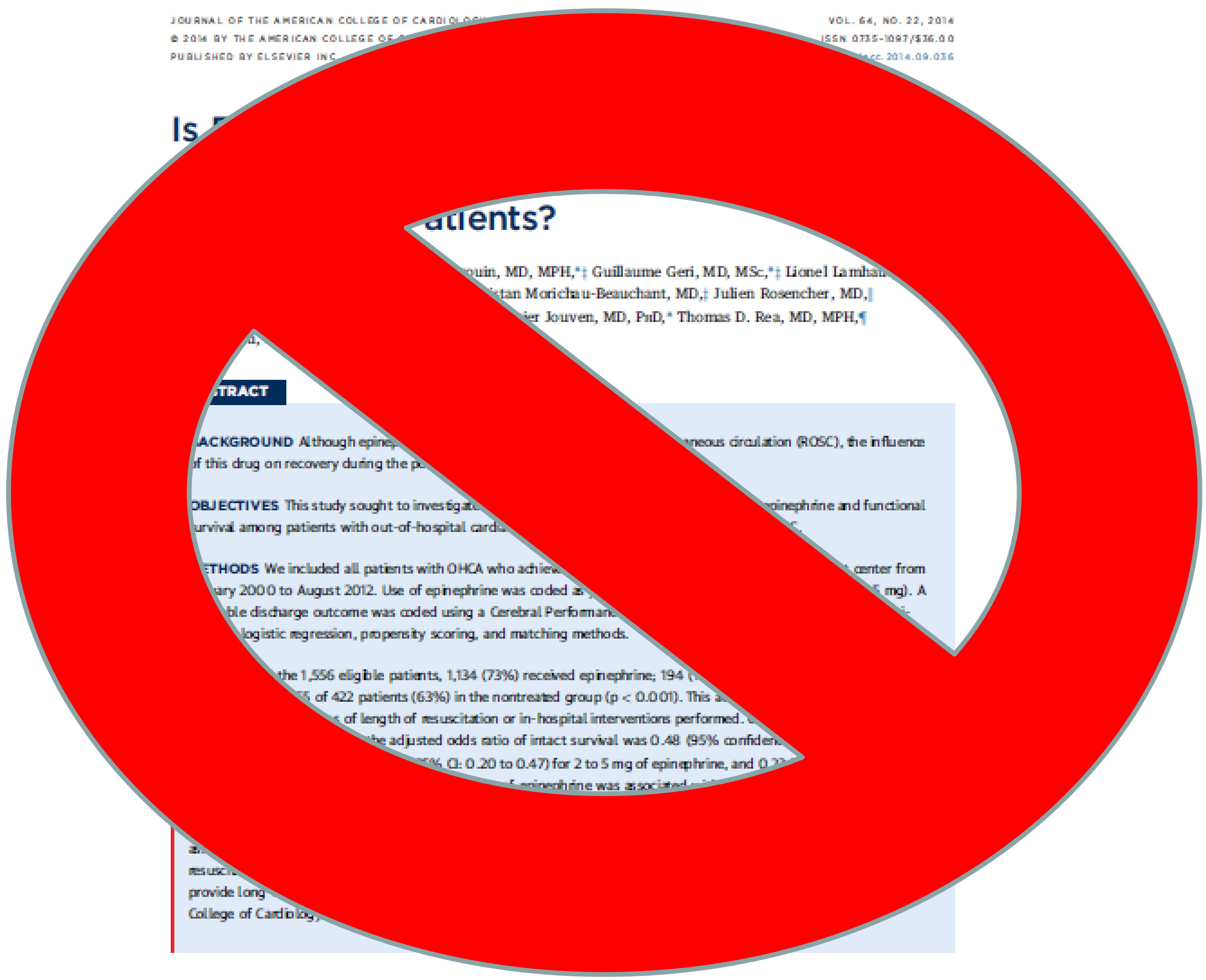
Advanced Cardiac Arrest


JOURNAL OF THE AMERICAN COLLEGE OF CARDIOLOG... VOL. 64, NO. 22, 2014
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PUBLISHED BY ELSEVIER INC. ...jacc.2014.09.036

Is E... atients?

...ouin, MD, MPH,*† Guillaume Geri, MD, MSc,*† Lionel Lamhau...
...istan Moricha u-Beauchant, MD,† Julien Rosencher, MD,‖
...ier Jouven, MD, PhD,* Thomas D. Rea, MD, MPH,¶

...TRACT

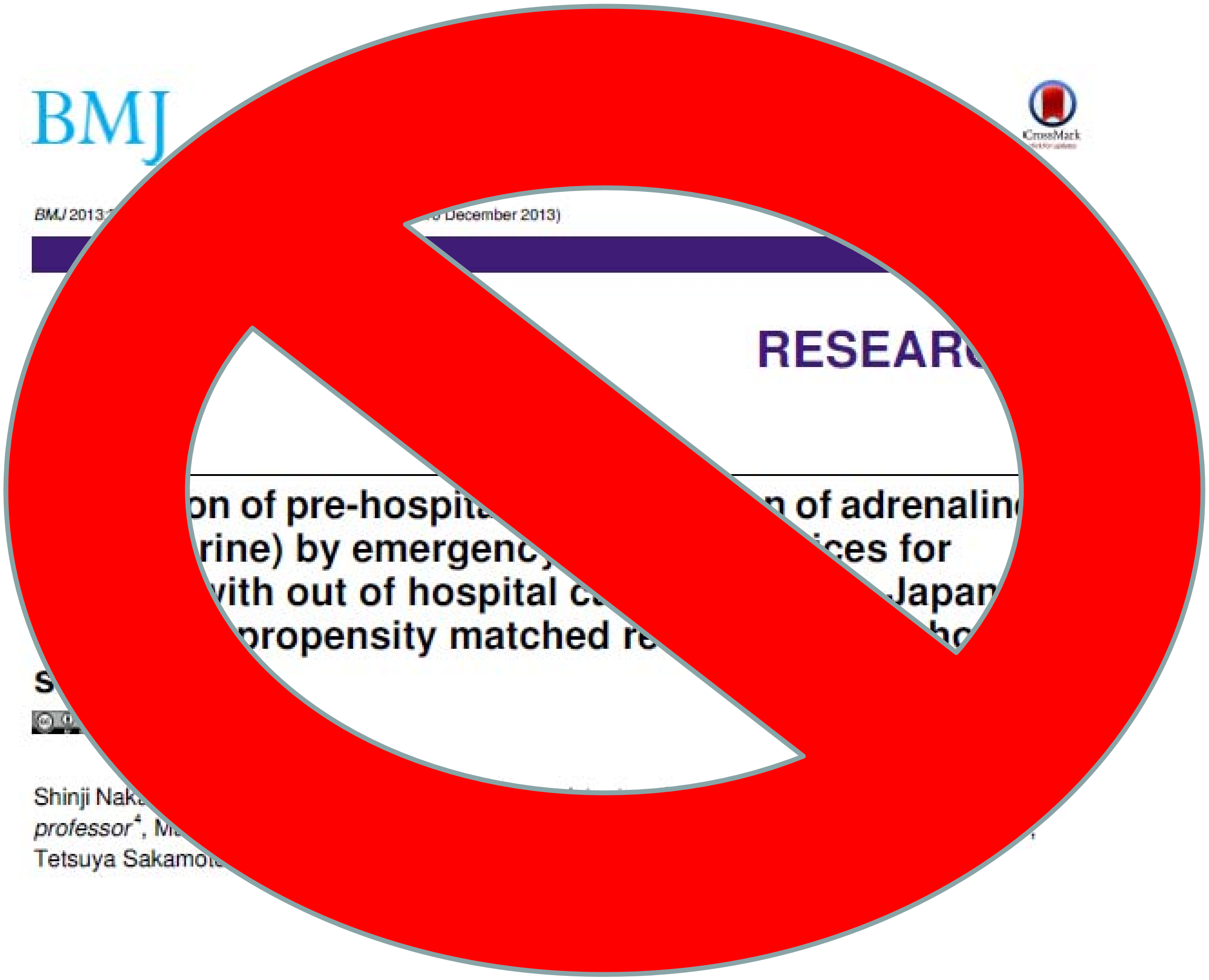
...ACKGROUND Although epine... ...neous circulation (ROSC), the influence of this drug on recovery during the p...

OBJECTIVES This study sought to investigat... ...pinephrine and functional survival among patients with out-of-hospital cardi...

...ETHODS We included all patients with OHCA who achiev... ...center from ...ary 2000 to August 2012. Use of epinephrine was coded as... ...mg). A ...ble discharge outcome was coded using a Cerebral Performan... ...logistic regression, propensity scoring, and matching methods.

...the 1,556 eligible patients, 1,134 (73%) received epinephrine; 194 (... ...55 of 422 patients (63%) in the nontreated group (p < 0.001). This a... ...s of length of resuscitation or in-hospital interventions performed. ... ...he adjusted odds ratio of intact survival was 0.48 (95% confiden... ...95% CI: 0.20 to 0.47) for 2 to 5 mg of epinephrine, and 0.3...

MMH/EMA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Japan
propensity matched re
Shinji Nak
professor
Tetsuya Sakamot

RUTGERS

Advanced Cardiac Arrest

CARING FOR THE CRITICALLY ILL PATIENT

Prehospital Epinephri… Patients With Out… …diac Arrest

Akihito Hagihara, DMSc, MPH
Manabu Hasegawa, MD
Takeru Abe, MA
Takashi Nagata, MD
Yoshifumi Wakata, MD
Shogo Miyazaki, PhD

EPINEPHRINE IS WIDELY USED I… cardiopulmonary resuscita… tion (CPR) for patients wit… out-of-hospital cardiac arres… (OHCA).[1-3] However, its effectivenes… in CPR has not been established. Epinephrine is associated with increased myocardial oxygen consumption and ventricular arrhythmias during the period after resuscitation.[4] Concern has been raised regarding increased myocardial dysfunction[5,6] and disturbed cerebral microcirculation after cardiac arrest.[7] Findings in support of epinephrine use include animal studies that show a beneficial short-term effect of epinephrine,[8,9] and evidence of increased cerebral and coronary perfusion by redirected peripheral blood flow has been reported.[10,11]

To verify the effectiveness of epinephrine in CPR, the influences of other factors, such as patients, bystanders, CPR by bystanders, life support by emergency medical service (EMS) personnel, and time from call to the scene or hospital arrival, need to be controlled. To control for the effects of co-…

…suscitation for out-of-… …ephrine use before … …en es… …the associa… …hospital ar-… …ng-term mortalit…

…d Participants Prosp… …ta from 417 188 OHCAs occ… …rs or older had an OHCA before… …re treated by EMS personnel, and w…

…easures Return of spontaneous circu… …onth after cardiac arrest, survival with goo… …l Performance Category [CPC] 1 or 2), and su… …ical disability (Overall Performance Category [C…

…ntaneous circulation before hospital arrival was obser… …in the epinephrine group and 23 042 of 402 158 patients … …(P<.001); it was observed in 2446 (18.3%) and 1400 (10.… …l patients, respectively (P<.001). In the total sample, the … …h survival and survival with CPC 1 or 2 and OPC 1 or 2, … resp… …4%), and 211 (1.4%) with epinephrine and 18 906 (4.7… …without epinephrine (all P<.001). Correspond-ing nu… …687 (5.1%), 173 (1.3%), and 178 (1.3%) with epi… …10 (3.1%) without epinephrine (all P<.001). In… …ween prehospital epi-nephrine and … tio [OR], 2.36; 95… association was also … trast, among all patients, … nephrine and long-term outco… CI, 0.42-0.51]; CPC 1-2, 0.31 [95… 0.38]; all P<.001). Similar negative ass… matched patients (adjusted ORs: 1-month survival, … 0.21 [95% CI, 0.10-0.44]; and OPC 1-2, 0.23 [95% CI, 0.1…

Conclusion Among patients with OHCA in Japan, use of prehospital epinephrine was significantly associated with increased chance of return of spontaneous circulation before hospital arrival but decreased chance of survival and good functional outcomes 1 month after the event.

JAMA. 2012;307(11):1161-1168 www.jama.com

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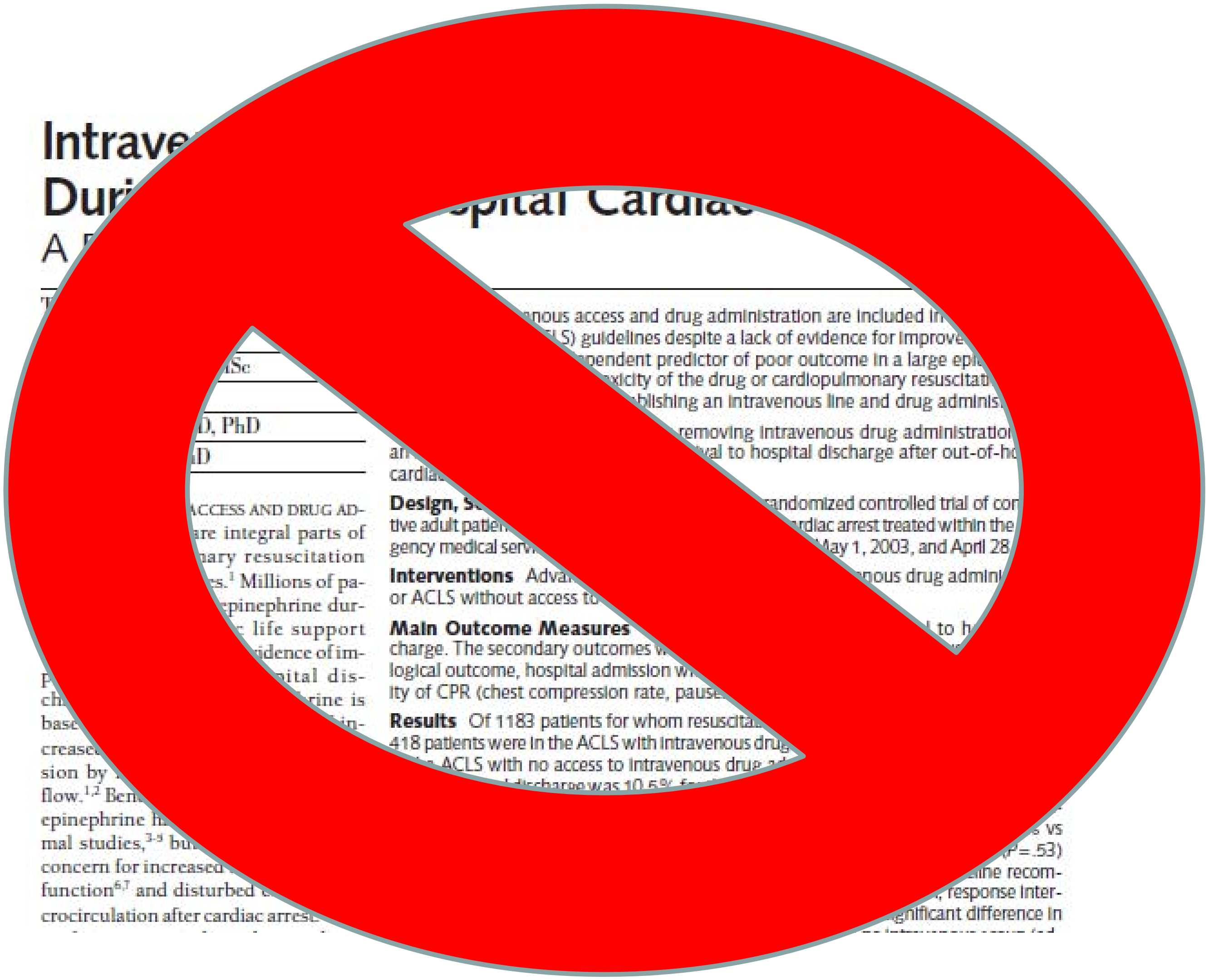
Advanced Cardiac Arrest



AUSTRALIAN RESUSCITATION COUNCIL

NEW ZEALAND Resuscitation Council
Whakahauora, Aotearoa

Other drugs:
There is no convincing evidence that the routine use of other drugs (atropine, amiodarone, lidocaine, procainamide, bretylium, magnesium, buffers, calcium, hormones or fibrinolytics) during human CPR increases survival to hospital discharge.[4]

Vasopressors:
Despite the continued widespread use of adrenaline and increased use of vasopressin during resuscitation in some countries, there is no placebo-controlled study that shows that the routine use of any vasopressor during human cardiac arrest increases survival to hospital discharge.[4] Although there is evidence that vasopressors (adrenaline or vasopressin) may improve return of spontaneous circulation and short-term survival, there is insufficient evidence to suggest that vasopressors improve survival to discharge and neurologic outcome. There is insufficient evidence to suggest the optimal dosage of any vasopressor in the treatment of adult cardiac arrest. Given the observed benefit in short-term outcomes, the use of adrenaline or vasopressin may be considered in adult cardiac arrest.[4] [Class A; Expert consensus opinion]

Circulation Journal
Official Journal of the Japanese Circulation Society
http://www.j-circ.or.jp

ORIGINAL ARTICLE
Critical Care

Impact of Early Intravenous Epinephrine Administration on Outcomes Following Out-of-Hospital Cardiac Arrest

Yasuyuki Hayashi, MD, PhD; Taku Iwami, MD, PhD; Tetsuhisa Kitamura, MD; Tatsuya Nishiuchi, MD, PhD; Kentaro Kajino, MD, PhD; Tomohiko Sakai, MD, PhD; Chika Nishiyama, PhD; Masahiko Nitta, MD, PhD; Atsushi Hiraide, MD, PhD; Tatsuro Kai, MD

Background: The effectiveness of epinephrine administration for cardiac arrests has been shown in animal models, but the clinical effect is still controversial.

Methods and Results: A prospective, population-based, observational study in Osaka involved consecutive out-of-hospital cardiac arrest (OHCA) patients from January 2007 through December 2009. We evaluated the outcomes among adult non-traumatic bystander-witnessed OHCA patients for whom the local protocol directed the emergency medical service personnel to administer epinephrine. After stratifying by first documented cardiac rhythm, outcomes were compared among the following groups: non-administration, ≤10, 11–20 and ≥21 min as the time from emergency call to epinephrine administration. A total of 3,161 patients were eligible for our analyses, among whom 1,013 (32.0%) actually received epinephrine. The epinephrine group had a significantly lower rate of neurologically intact 1-month survival than the non-epinephrine group (4.1% vs. 6.1%, P=0.028). In cases of ventricular fibrillation (VF) arrest, patients in the early epinephrine group who received epinephrine administration within 10 min had a significantly higher rate of neurologically intact 1-month survival compared with the non-epinephrine group (66.7% vs. 24.9%), though other epinephrine groups did not. In cases of non-VF arrest, the rate of neurologically intact 1-month survival was low, irrespective of epinephrine administration.

Conclusions: The effectiveness of epinephrine after OHCA depends on the time of administration. When epinephrine is administered in the early phase, there is an improvement in neurological outcome from OHCA with VF. (*Circ J* 2012; **76:** 1639–1645)

Key Words: Cardiac arrest; Cardiopulmonary resuscitation; Epidemiology; Epinephrine; Sudden death

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EUROPEAN RESUSCITATION COUNCIL

Clinical Paper

Volume versus outcome: More emergency medical services personnel on-scene and increased survival after out-of-hospital cardiac arrest☆

Sam A. Warren[a,b,*], David K. Prince[d,g], Ella Huszti[a,b], Tom D. Rea[b], Annette L. Fitzpatrick[c,e,f], Douglas L. Andrusiek[h], Steve Darling[i], Laurie J. Morrison[j], Gary M. Vilke[k], Graham Nichol[a,b,g], the ROC Investigators

ELSEVIER
Resuscitation 65 (2005) 57–64
RESUSCITATION
www.elsevier.com/locate/resuscitation

Prospective use of a clinical decision rule to identify pulmonary embolism as likely cause of outpatient cardiac arrest☆

D. Mark Courtney[a,1], Jeffrey A. Kline[b,*]

[a] *Department of Emergency Medicine, Feinberg School of Medicine, Northwestern University, Emergency Medicine, 259 E. Erie Suite 100, Chicago, IL 60611, USA*
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Received 14 March 2004; received in revised form 27 July 2004; accepted 27 July 2004

1. age <65 years;
2. witnessed arrest (using Utstein criteria);
3. presence of pulseless electrical activity as the first rhythm.

This prospective observational study evaluated a previously derived clinical decision rule designed to identify patients with cardiac arrest who are at high risk for massive PE. This work supported previous findings and resulted in the identification of a population of outpatients with cardiac arrest characterized by PEA, who have a prevalence of PE of greater than 50%. These same patients with PE were more likely to suffer cardiac arrest in the presence of an emergency doctor or paramedic than those identified by the decision rule who did not have PE. The patients with PE also commonly had the triad of respiratory distress, alterations of mental status, and shock prior to arrest.

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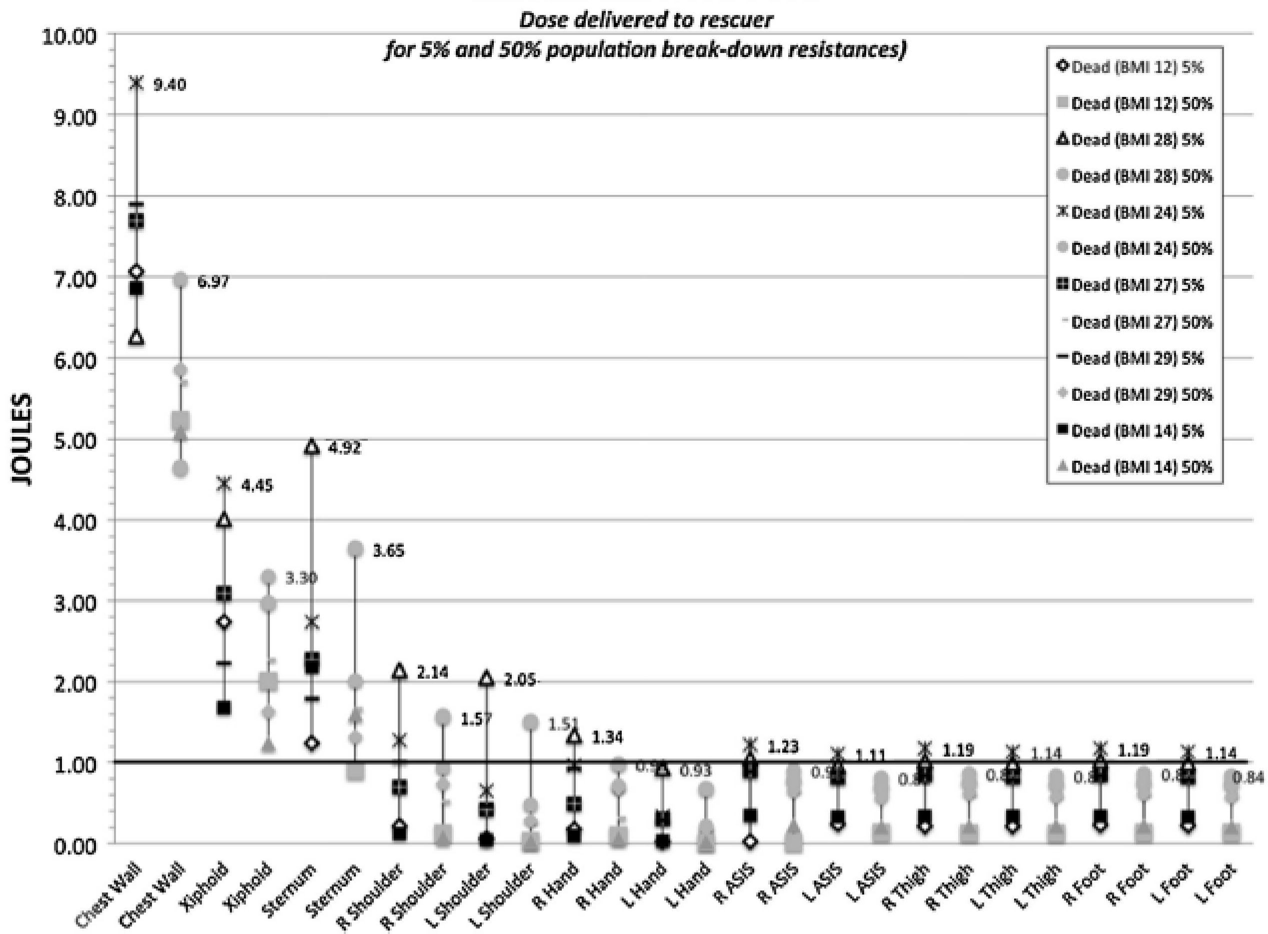
Resuscitation

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

Clinical Paper

Electrical exposure risk associated with hands-on defibrillation☆



MMH/EI

Fig. 6. The rescuer-received dose is noted at the various measurement points using published rescuer skin resistances for both 5% and 50% population thresholds. The horizontal line at 1 J indicates the minimum energy level that is able to cause ventricular fibrillation in a susceptible individual.[15] On the anterior chest wall, where contact would be made with HOD, the energy level is 6–10 times the level needed to cause fibrillation.

JACC Vol. 23, No. 5
April 1994:1141–5

1141

Double Sequential External Shocks for Refractory Ventricular Fibrillation

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STEVEN M. GREENBERG, MD, FACC, CRAIG M. McPHERSON, MD, FACC,*
LYNDA E. ROSENFELD, MD, FACC,* MARK MARIEB, MD,*
JOSEPH H. LEVINE, MD, FACC

Roslyn, New York and New Haven, Connecticut

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.

Conclusions. This report stresses the importance of an additional defibrillator being readily available during electrophysiologic testing. This technique of rapid, double sequential external shocks may have general applicability, providing a simple and potentially lifesaving approach to refractory ventricular fibrillation.

(J Am Coll Cardiol 1994;23:1141–5)

Prehosp Emerg Care. 2015 January-March;19(1):126-130. Epub 2014 Sep 22.

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

Cabañas JG, Myers JB, Williams JG, De Maio VJ, Bachman MW.

Abstract

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 5 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 charged 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 51minutes (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.

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

PMID: 25243771 [PubMed - as supplied by publisher]

Treating Electrical Storm

Sympathetic Blockade Versus Advanced Cardiac Life Support–Guided Therapy

Koonlawee Nademanee, MD; Richard Taylor, MD; William E. Bailey, MD;
Daniel E. Rieders, MD; Erol M. Kosar, MD

Background**—**Electrical storm (ES), defined as recurrent multiple ventricular fibrillation (VF) episodes, often occurs in patients with recent myocardial infarction. Because treating ES according to the Advanced Cardiac Life Support (ACLS) guidelines yields a poor outcome, we evaluated the efficacy of sympathetic blockade in treating ES patients and compared their outcome with that of patients treated according to the ACLS guidelines.

Methods and Results**—**Forty-nine patients (36 men, 13 women, mean age 57±10 years) who had ES associated with a recent myocardial infarction were separated into 2 groups. Patients in group 1 (n=27) received sympathetic blockade treatment: 6 left stellate ganglionic blockade, 7 esmolol, and 14 propranolol. Patients in group 2 (n=22) received antiarrhythmic medication as recommended by the ACLS guidelines. Patient characteristics were similar in the 2 groups. The 1-week mortality rate was higher in group 2: 18 (82%) of the 22 patients died, all of refractory VF; 6 (22%) of the 27 group 1 patients died, 3 of refractory VF ($P<0.0001$). Patients who survived the initial ES event did well over the 1-year follow-up period: Overall survival in group 1 was 67%, compared with 5% in group 2 ($P<0.0001$).

Conclusions**—**Sympathetic blockade is superior to the antiarrhythmic therapy recommended by the ACLS guidelines in treating ES patients. Our study emphasizes the role of increased sympathetic activity in the genesis of ES. Sympathetic blockade−not class 1 antiarrhythmic drugs−should be the treatment of choice for ES. (***Circulation*****. 2000;102:742-747.)**

Contents lists available at ScienceDirect

Resuscitation

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

ELSEVIER

RESUSCITATION

Clinical paper

Use of esmolol after failure of standard cardiopulmonary resuscitation to treat patients with refractory ventricular fibrillation

CrossMark

Brian E. Driver[a,*], Guillaume Debaty[a,b,c], David W. Plummer[a], Stephen W. Smith[a]

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Cardiopulmonary resuscitation
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Cardiac arrest

ABSTRACT

Introduction: We compare the outcomes for patients who received esmolol to those who did not receive esmolol during refractory ventricular fibrillation (RVF) in the emergency department (ED).
Methods: A retrospective investigation in an urban academic ED of patients between January 2011 and January 2014 of patients with out-of-hospital or ED cardiac arrest (CA) with an initial rhythm of ventricular fibrillation (VF) or ventricular tachycardia (VT) who received at least three defibrillation attempts, 300 mg of amiodarone, and 3 mg of adrenaline, and who remained in CA upon ED arrival. Patients who received esmolol during CA were compared to those who did not.
Results: 90 patients had CA with an initial rhythm of VF or VT; 65 patients were excluded, leaving 25 for analysis. Six patients received esmolol during cardiac arrest, and nineteen did not. All patients had ventricular dysrhythmias refractory to many defibrillation attempts, including defibrillation after administration of standard ACLS medications. Most received high doses of adrenaline, amiodarone, and sodium bicarbonate. Comparing the patients that received esmolol to those that did not: 67% and 42% had temporary return of spontaneous circulation (ROSC); 67% and 32% had sustained ROSC; 66% and 32% survived to intensive care unit admission; 50% and 16% survived to hospital discharge; and 50% and 11% survived to discharge with a favorable neurologic outcome, respectively.
Conclusion: Beta-blockade should be considered in patients with RVF in the ED prior to cessation of resuscitative efforts.

END-TIDAL CARBON DIOXIDE AND OUTCOME OF OUT-OF-HOSPITAL CARDIAC ARREST

ROBERT L. LEVINE, M.D., MARVIN A. WAYNE, M.D., AND CHARLES C. MILLER, PH.D.

TABLE 1. END-TIDAL CARBON DIOXIDE VALUES IN PATIENTS WHO SURVIVED TO HOSPITAL ADMISSION AND IN THOSE WHO DID NOT.

VARIABLE	NONSURVIVORS (N=115)	SURVIVORS (N=35)	P VALUE*
	mean ±SD (range)		
Age (yr)	68.0±13.8 (31–95)	71.5±13.0 (27–90)	0.19
End-tidal carbon dioxide (mm Hg)†			
Initial	12.3±6.9 (2–50)	12.2±4.6 (5–22)	0.93
Final	4.4±2.9 (0–10)	32.8±7.4 (18–58)	<0.001

*P values were calculated with the Wilcoxon rank–sum statistic.

†Initial end-tidal carbon dioxide levels were determined immediately upon intubation. Final end-tidal carbon dioxide levels were determined after 20 minutes of advanced cardiac life support.

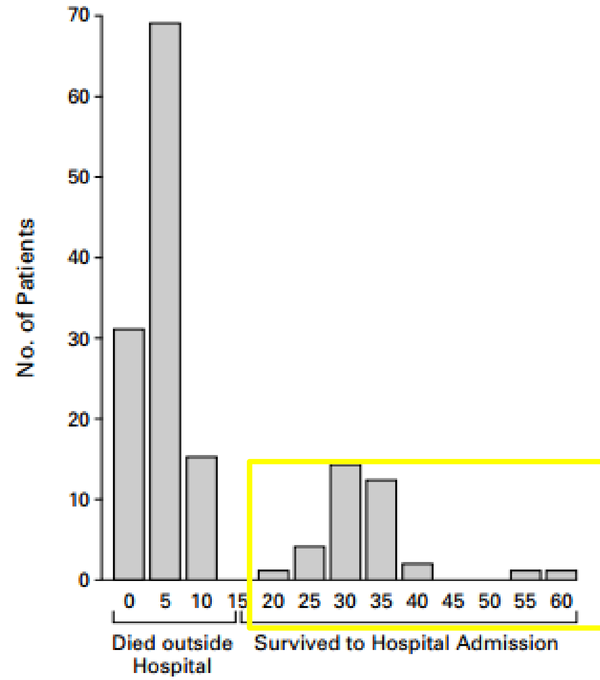

Figure 1. Histogram of Number of Patients (Frequency) at Each Value for End-Tidal Carbon Dioxide, with Standard "Midpoint" Groupings.

The majority of the patients were in the group with end-tidal carbon dioxide levels of 10 mm Hg or less, and all these patients died before reaching the hospital. The frequency distribution clearly differentiates between survivors and nonsurvivors. Values are given as standard midpoint groupings for ease of presentation.

1. **End-tidal** PCO2 during cardiopulmonary resuscitation.
Weil MH, Gazmuri RJ, Kette F, Bisera J, Rackow EC.
JAMA. 1990 Feb 9;263(6):814-5. No abstract available.
PMID: 2104943
Similar articles

2. **End-tidal carbon dioxide monitoring** during cardiopulmonary resuscitation. A prognostic indicator for survival.
Sanders AB, Kern KB, Otto CW, Milander MM, Ewy GA.
JAMA. 1989 Sep 8;262(10):1347-51.
PMID: 2761035
Similar articles

3. **End-tidal carbon dioxide monitoring** during cardiopulmonary resuscitation.
Garnett AR, Ornato JP, Gonzalez ER, Johnson EB.
JAMA. 1987 Jan 23-30;257(4):512-5.
PMID: 3098993
Similar articles

J Intensive Care Med. 2014 Apr 22. [Epub ahead of print]

Systematic Review and Meta-Analysis of End-Tidal Carbon Dioxide Values Associated With Return of Spontaneous Circulation During Cardiopulmonary Resuscitation.

Hartmann SM[1], Farris RW, Di Gennaro JL, Roberts JS.

⊕ Author information

Abstract

OBJECTIVE: End-tidal carbon dioxide ($ETCO_2$) measurements during cardiopulmonary resuscitation (CPR) reflect variable cardiac output over time, and low values have been associated with decreased survival. The goals of this review are to confirm and quantify this relationship and to determine the mean $ETCO_2$ value among patients with return of spontaneous circulation (ROSC) as an initial step toward determining an appropriate target for intervention during resuscitation in the absence of prospective data.

DATA SOURCES AND STUDY SELECTION: The PubMed database was searched for the key words "end-tidal carbon dioxide" or "capnometry" or "capnography" and "resuscitation" or "return of spontaneous circulation." Randomized controlled trials, cohort studies, or case-control studies that reported $ETCO_2$ values for participants with and without ROSC were included.

DATA EXTRACTION AND SYNTHESIS: Twenty-seven studies met the inclusion criteria for qualitative synthesis. Twenty studies were included in determination of average $ETCO_2$ values. The mean $ETCO_2$ in participants with ROSC was 25.8 ± 9.8 mm Hg versus 13.1 ± 8.2 mm Hg ($P = .001$) in those without ROSC. Nineteen studies were included in a meta-analysis. The mean difference in $ETCO_2$ was 12.7 mm Hg (95% confidence interval: 10.3-15.1) between participants with and without ROSC ($P < .001$). The mean difference in $ETCO_2$ was not modified by the receipt of sodium bicarbonate, uncontrolled minute ventilation, or era of resuscitation guidelines. The overall quality of data by Grades of Recommendations, Assessment, Development and Evaluation criteria is very low, but no prospective data are currently available.

CONCLUSIONS: Participants with ROSC after CPR have statistically higher levels of $ETCO_2$. The average $ETCO_2$ level of 25 mm Hg in participants with ROSC is notably higher than the threshold of 10 to 20 mm Hg to improve delivery of chest compressions. The $ETCO_2$ goals during resuscitation may be higher than previously suggested and further investigation into appropriate targets during resuscitation is needed to diminish morbidity and mortality after cardiorespiratory arrest.

KEYWORDS: capnography; end-tidal carbon dioxide; meta-analysis; mortality; resuscitation

PMID: 24756307 [PubMed - as supplied by publisher]

ELSEVIER

Resuscitation

Volume 81, Issue 4, April 2010, Pages 383–387

Clinical paper

Cardiac arrest in the catheterisation laboratory: A 5-year experience of using mechanical chest compressions to facilitate PCI during prolonged resuscitation efforts ☆

Henrik Wagner[a], Christian J. Terkelsen[b], Hans Friberg[c], Jan Harnek[a], Karl Kern[d], Jens Flensted Lassen[b], Goran K. Olivecrona[a]

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http://www.mckinneyonline.com/March-2015/McKinney-Fire-Department-Implements-New-Life-Saving-Technology/

Post Arrest Management

The New England
Journal of Medicine

VOLUME 346 FEBRUARY 21, 2002 NUMBER 8

MILD THERAPEUTIC HYPOTHERMIA TO IMPROVE THE NEUROLOGIC OUTCOME AFTER CARDIAC ARREST

THE HYPOTHERMIA AFTER CARDIAC ARREST STUDY GROUP*

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

Targeted Temperature Management at 33°C versus 36°C after Cardiac Arrest

Niklas Nielsen, M.D., Ph.D., Jørn Wetterslev, M.D., Ph.D., Tobias Cronberg, M.D., Ph.D., David Erlinge, M.D., Ph.D., Yvan Gasche, M.D., Christian Hassager, M.D., D.M.Sci., Janneke Horn, M.D., Ph.D., Jan Hovdenes, M.D., Ph.D., Jesper Kjaergaard, M.D., D.M.Sci., Michael Kuiper, M.D., Ph.D., Tommaso Pellis, M.D., Pascal Stammet, M.D., Michael Wanscher, M.D., Ph.D., Matt P. Wise, M.D., D.Phil., Anders Åneman, M.D., Ph.D., Nawaf Al-Subaie, M.D., Søren Boesgaard, M.D., D.M.Sci., John Bro-Jeppesen, M.D., Iole Brunetti, M.D., Jan Frederik Bugge, M.D., Ph.D., Christopher D. Hingston, M.D., Nicole P. Juffermans, M.D., Ph.D., Matty Koopmans, R.N., M.Sc., Lars Køber, M.D., D.M.Sci., Jørund Langørgen, M.D., Gisela Lilja, O.T., Jacob Eifer Møller, M.D., D.M.Sci., Malin Rundgren, M.D., Ph.D., Christian Rylander, M.D., Ph.D., Ondrej Smid, M.D., Christophe Werer, M.D., Per Winkel, M.D., D.M.Sci., and Hans Friberg, M.D., Ph.D., for the TTM Trial Investigators*


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Resuscitation 85 (2014) 1612–1618

Contents lists available at ScienceDirect

Resuscitation

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Clinical Paper

Myocardial infarction is a frequent cause of exercise-related resuscitated out-of-hospital cardiac arrest in a general non-athletic population

Helle Søholm[a,*], Jesper Kjaergaard[a], Jakob Hartvig Thomsen[a], John Bro-Jeppesen[a], Freddy K. Lippert[b], Lars Køber[a], Michael Wanscher[c], Christian Hassager[a]

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Exercise
Cardiopulmonary resuscitation
Cardiac arrest
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Myocardial infarction

ABSTRACT

Background: Performing exercise is shown to prevent cardiovascular disease, but the risk of an out-of-hospital cardiac arrest (OHCA) is temporarily increased during strenuous activity. We examined the etiology and outcome after successfully resuscitated OHCA during exercise in a general non-athletic population.
Methods: Consecutive patients with OHCA were admitted with return of spontaneous circulation (ROSC) or on-going resuscitation at hospital arrival (2002–2011). Patient charts were reviewed for post-resuscitation data. Exercise was defined as moderate/vigorous physical activity.
Results: A total of 1393 OHCA-patients were included with 91(7%) arrests occurring during exercise. Exercise-related OHCA-patients were younger (60 ± 13 vs. 65 ± 15, p < 0.001) and predominantly male (96% vs. 69%, p < 0.001). The arrest was more frequently witnessed (94% vs. 86%, p = 0.02), bystander CPR was more often performed (88% vs. 54%, p < 0.001), time to ROSC was shorter (12 min (IQR: 5–19) vs. 15 (9–22), p = 0.007) and the primary rhythm was more frequently shock-able (91% vs. 49%, p < 0.001) compared to non-exercise patients. Cardiac etiology was the predominant cause of OHCA in both exercise and non-exercise patients (97% vs. 80%, p < 0.001) and acute coronary syndrome was more frequent among exercise patients (59% vs. 38%, p < 0.001). One-year mortality was 25% vs. 65% (p < 0.001), and exercise was even after adjustment associated with a significantly lower mortality (HR = 0.40 (95%CI: 0.23–0.72), p = 0.002).
Conclusions: OHCA occurring during exercise was associated with a significantly lower mortality in successfully resuscitated patients even after adjusting for confounding factors. Acute coronary syndrome was more common among exercise-related cardiac arrest patients.

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Resuscitation
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Clinical paper

Cardiac catheterization is associated with superior outcomes for survivors of out of hospital cardiac arrest: Review and meta-analysis☆

Anthony C. Camuglia[a,b,c,*], Varinder K. Randhawa[d], Shahar Lavi[d], Darren L. Walters[c,e]

1536 A.C. Camuglia et al. / Resuscitation 85 (2014) 1533–1540

	Acute angiography		No acute Angiography			Odds Ratio
Study or Subgroup	Events	Total	Events	Total	Weight	M–H, Random, 95% CI
Aurore 2011	31	133	30	312	8.2%	2.86 [1.65, 4.96]
Bro–Jeppesen 2012	129	198	87	162	9.3%	1.61 [1.05, 2.47]
Bulut 1999	4	10	10	27	2.9%	1.13 [0.26, 5.01]
Cronier 2011	54	91	6	20	4.7%	3.41 [1.20, 9.67]
Grasner 2011	80	154	57	430	9.3%	7.07 [4.64, 10.78]
Hollenbeck 2013	80	122	71	147	8.7%	2.04 [1.24, 3.34]
Mooney 2011	63	101	15	39	6.5%	2.65 [1.24, 5.67]
Nanjayya 2012	18	35	12	35	5.2%	2.03 [0.78, 5.31]
Nielsen 2009	303	479	187	507	10.6%	2.95 [2.27, 3.82]
Reynolds 2009	40	63	22	33	5.6%	0.87 [0.36, 2.11]
Strote 2012	44	61	88	179	7.5%	2.68 [1.42, 5.03]
Tomte 2011	76	145	9	29	5.9%	2.45 [1.04, 5.74]
Waldo 2013	57	84	7	26	5.1%	5.73 [2.15, 15.27]
Werling 2007	19	28	10	57	4.7%	9.92 [3.48, 28.25]
Zanuttini 2012	33	48	21	45	5.9%	2.51 [1.08, 5.86]
Total (95% CI)		**1752**		**2048**	**100.0%**	**2.77 [2.06, 3.72]**
Total events	1031		632			

Heterogeneity: $Tau^2 = 0.20$; $Chi^2 = 43.27$, $df = 14$ ($P < 0.0001$); $I^2 = 68\%$
Test for overall effect: $Z = 6.79$ ($P < 0.00001$)

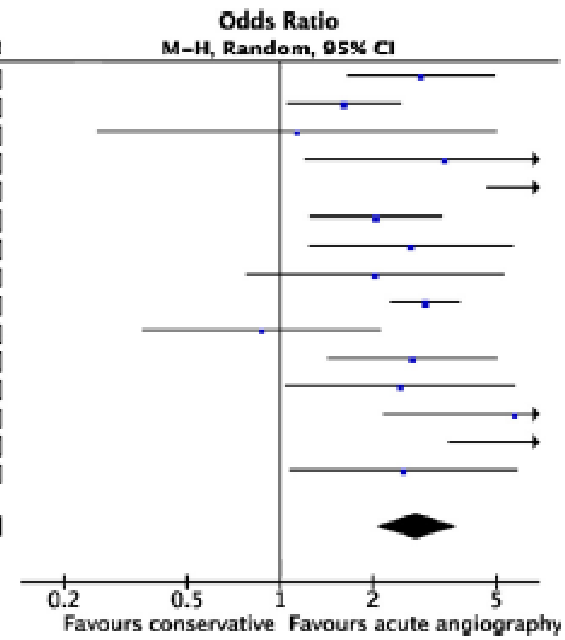

Fig. 2. Weighted hazard effects model of the relationship between acute coronary angiography and survival after OHCA.

Resuscitation 85 (2014) 88–95

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Resuscitation

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Clinical Paper

Early cardiac catheterization is associated with improved survival in comatose survivors of cardiac arrest without STEMI☆

Ryan D. Hollenbeck[a,*,1], John A. McPherson[a,1], Michael R. Mooney[b], Barbara T. Unger[b], Nainesh C. Patel[c], Paul W. McMullan Jr.[d], Chiu-Hsieh Hsu[e], David B. Seder[f], Karl B. Kern[g]

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ABSTRACT

Aim: To determine if early cardiac catheterization (CC) is associated with improved survival in comatose patients who are resuscitated after cardiac arrest when electrocardiographic evidence of ST-elevation myocardial infarction (STEMI) is absent.
Methods: We conducted a retrospective observational study of a prospective cohort of 754 consecutive comatose patients treated with therapeutic hypothermia (TH) following cardiac arrest.
Results: A total of 269 (35.7%) patients had cardiac arrest due to a ventricular arrhythmia without STEMI and were treated with TH. Of these, 122 (45.4%) received CC while comatose (early CC). Acute coronary occlusion was discovered in 26.6% of patients treated with early CC compared to 29.3% of patients treated with late CC ($p = 0.381$). Patients treated with early CC were more likely to survive to hospital discharge compared to those not treated with CC (65.6% vs. 48.6%; $p = 0.017$). In a multivariate regression model that included study site, age, bystander CPR, shock on admission, comorbid medical conditions, witnessed arrest, and time to return of spontaneous circulation, early CC was independently associated with a significant reduction in the risk of death (OR 0.35, 95% CI 0.18–0.70, $p = 0.003$).
Conclusions: In comatose survivors of cardiac arrest without STEMI who are treated with TH, early CC is associated with significantly decreased mortality. The incidence of acute coronary occlusion is high, even when STEMI is not present on the postresuscitation electrocardiogram.

Resuscitation 85 (2014) 657–663

Contents lists available at ScienceDirect

Resuscitation

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

Clinical Paper

Early coronary angiography and induced hypothermia are associated with survival and functional recovery after out-of-hospital cardiac arrest☆

Clifton W. Callaway[a,*], Robert H. Schmicker[b], Siobhan P. Brown[b], J. Michael Albrich[c], Douglas L. Andrusiek[d], Tom P. Aufderheide[e], James Christenson[d], Mohamud R. Daya[f], David Falconer[g], Ruchika D. Husa[h], Ahamed H. Idris[i], Joseph P. Ornato[j], Valeria E. Rac[g], Thomas D. Rea[b], Jon C. Rittenberger[a], Gena Sears[b], Ian G. Stiell[k], ROC Investigators

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[b] University of Washington, Seattle, WA, United States
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[d] University of British Columbia, Vancouver, BC, United States
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[f] Oregon Health and Science University, Portland, OR, United States
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[i] University of Texas, Southwestern, Dallas, TX, United States
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Percutaneous coronary intervention
Fibrinolysis

ABSTRACT

Background: The rate and effect of coronary interventions and induced hypothermia after out-of-hospital cardiac arrest (OHCA) are unknown. We measured the association of early (≤24 h after arrival) coronary angiography, reperfusion, and induced hypothermia with favorable outcome after OHCA.
Methods: We performed a secondary analysis of a multicenter clinical trial (NCT00394706) conducted between 2007 and 2009 in 10 North American regions. Subjects were adults (≥18 years) hospitalized after OHCA with pulses sustained ≥60 min. We measured the association of early coronary catheterization, percutaneous coronary intervention, fibrinolysis, and induced hypothermia with survival to hospital discharge with favorable functional status (modified Rankin Score ≤ 3).
Results: From 16,875 OHCA subjects, 3981 (23.6%) arrived at 151 hospitals with sustained pulses. 1317 (33.1%) survived to hospital discharge, with 1006 (25.3%) favorable outcomes. Rates of early coronary catheterization (19.2%), coronary reperfusion (17.7%) or induced hypothermia (39.3%) varied among hospitals, and were higher in hospitals treating more subjects per year. Odds of survival and favorable outcome increased with hospital volume (per 5 subjects/year OR 1.06; 95%CI: 1.04–1.08 and OR 1.06; 95%CI: 1.04, 1.08, respectively). Survival and favorable outcome were independently associated with early coronary angiography (OR 1.69; 95%CI 1.06–2.70 and OR 1.87; 95%CI 1.15–3.04), coronary reperfusion (OR 1.94; 95%CI 1.34–2.82 and OR 2.14; 95%CI 1.46–3.14), and induced hypothermia (OR 1.36; 95%CI 1.01–1.83 and OR 1.42; 95%CI 1.04–1.94).
Interpretation: : Early coronary intervention and induced hypothermia are associated with favorable outcome and are more frequent in hospitals that treat higher numbers of OHCA subjects per year.

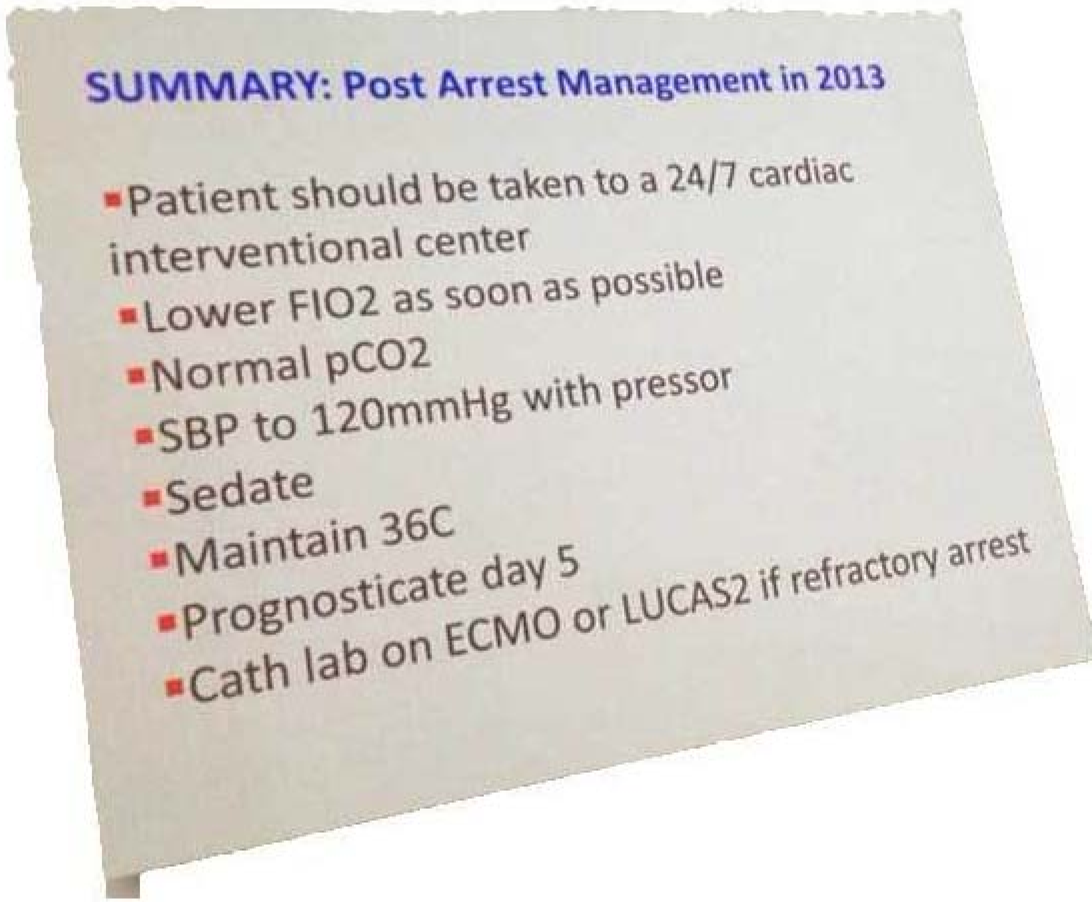

Photo by Brian Burns

http://emcrit.org/podcasts/post-arrest-care-2013-i/

Poor Prognosis

- absent pupillary response at 72 hours
- absent corneal reflex at 72 hours
- no motor response or extension to pain at 72 hours (i.e. worse than flexion)
- myoclonic status epilepticus (MSE); ie. generalized myoclonic convulsions in face and extremities and continuous for a minimum of 30 min
- bilateral absence of cortical SSEPs (N20 response) at 1 to 3 days
- serum neuron-specific enolase >33 µg/L at 1 to 3 days

http://lifeinthefastlane.com/ccc/prognosis-after-cardiac-arrest/

Less useful

- no CPR for > 8 minutes
- time to ROSC > 30 minutes
- duration of anoxic coma > 72 hours
- Burst suppression or generalized epileptiform discharges on EEG

http://lifeinthefastlane.com/ccc/prognosis-after-cardiac-arrest/

Good prognosis

- recovery of brainstem reflexes within 48 hours (papillary, corneal, oculocephalic)
- return of purposeful response within 24 hours
- primary pulmonary event leading to hypoxaemia
- hypothermia at time of arrest (emersion)
- young age

http://lifeinthefastlane.com/ccc/prognosis-after-cardiac-arrest/

Resuscitation

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

Clinical Paper

Bispectral Index to Predict Neurological Outcome Early After Cardiac Arrest☆

Pascal Stammet[a,*], Olivier Collignon[b], Christophe Werer[a], Claude Sertznig[a], Yvan Devaux[c]

[a] Department of Anaesthesia and Intensive Care Medicine, Centre Hospitalier de Luxembourg, 4, rue Barblé, L-1210 Luxembourg, Luxembourg
[b] Competence Centre for Methodology and Statistics, Centre de Recherche Public de la Santé (CRP-Santé), 1A-B, rue Thomas Edison, L-1445 Strassen, Luxembourg
[c] Laboratory of Cardiovascular Research, Centre de Recherche Public de la Santé (CRP-Santé), 84, Val Fleuri, L-1526 Luxembourg, Luxembourg

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Prognosis
Brain injury
Prediction models.

ABSTRACT

Aim of the study: To address the value of continuous monitoring of bispectral index (BIS) to predict neurological outcome after cardiac arrest.
Methods: In this prospective observational study in adult comatose patients treated by therapeutic hypothermia after cardiac arrest we measured bispectral index (BIS) during the first 24 hours of intensive care unit stay. A blinded neurological outcome assessment by cerebral performance category (CPC) was done 6 months after cardiac arrest.
Results: Forty-six patients (48%) had a good neurological outcome at 6-month, as defined by a cerebral performance category (CPC) 1-2, and 50 patients (52%) had a poor neurological outcome (CPC 3-5). Over the 24 h of monitoring, mean BIS values over time were higher in the good outcome group (38 ± 9) compared to the poor outcome group (17 ± 12) ($p < 0.001$). Analysis of BIS recorded every 30 minutes provided an optimal prediction after 12.5 h, with an area under the receiver operating characteristic curve (AUC) of 0.89, a specificity of 89% and a sensitivity of 86% using a cut-off value of 23. With a specificity fixed at 100% (sensitivity 26%) the cut-off BIS value was 2.4 over the first 271 minutes. In multivariable analyses including clinical characteristics, mean BIS value over the first 12.5 h was a predictor of neurological outcome ($p = 6E\text{-}6$) and provided a continuous net reclassification index of 1.28% ($p = 4E\text{-}10$) and an integrated discrimination improvement of 0.31 ($p = 1E\text{-}10$).
Conclusions: Mean BIS value calculated over the first 12.5 h after ICU admission potentially predicts 6-months neurological outcome after cardiac arrest.

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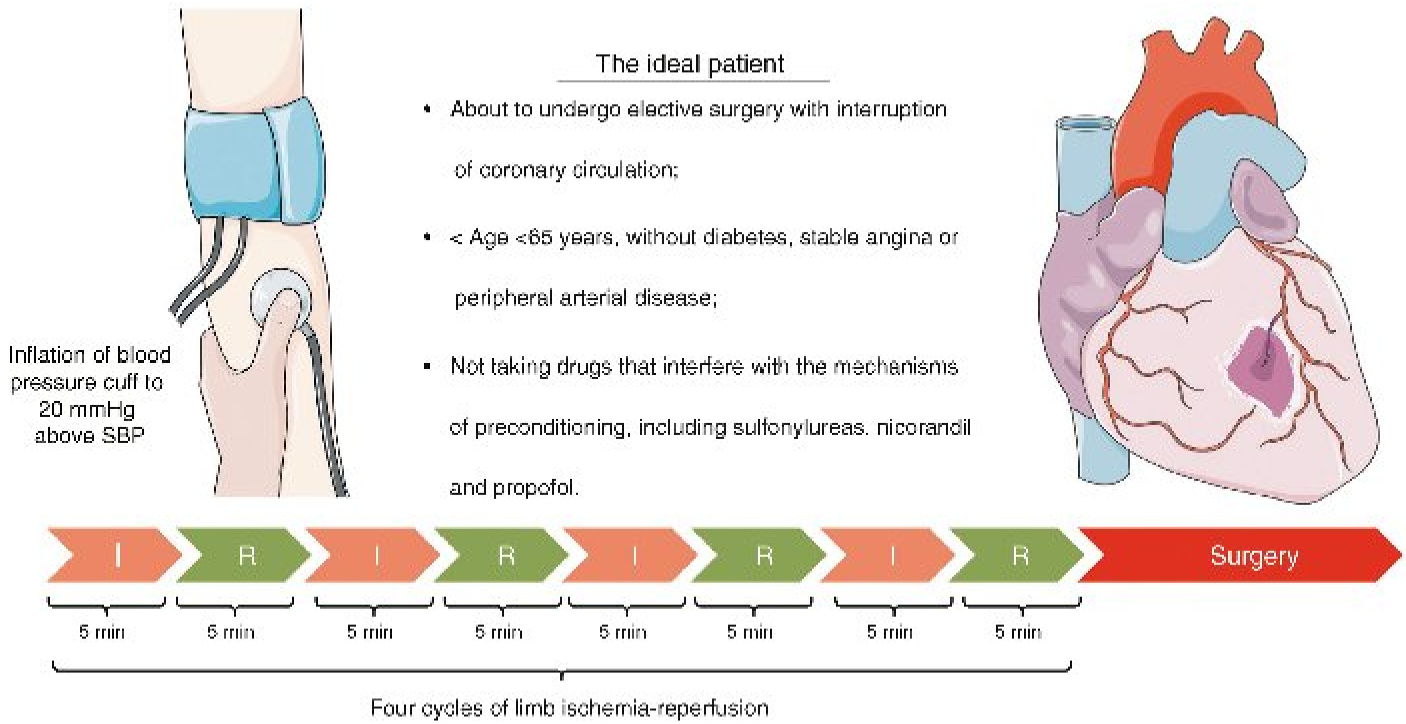
Arrest Management of the Future

Remote Ischemic Conditioning



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

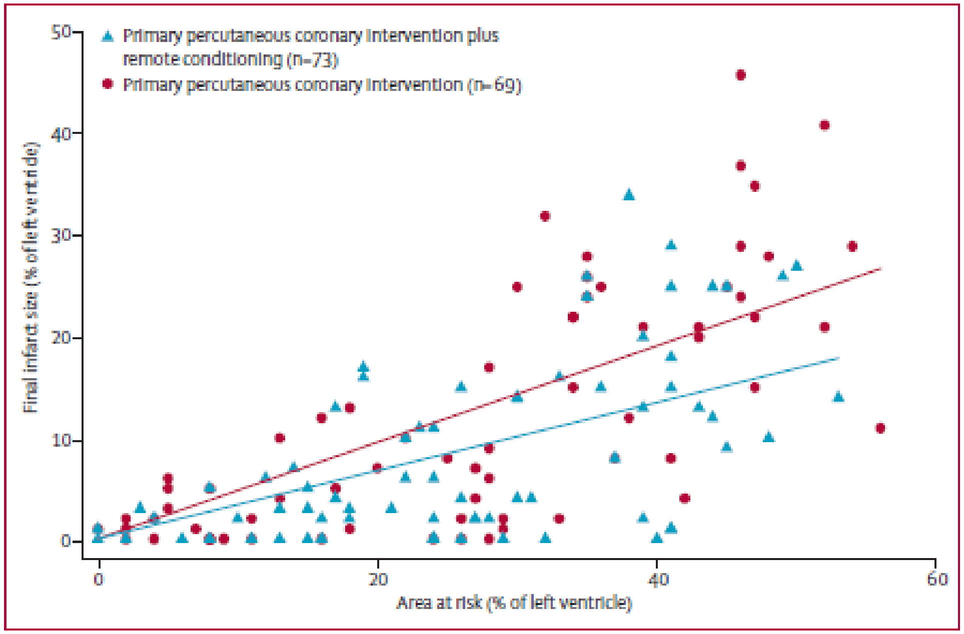


Figure 2: **Relation between final infarct size and area at risk for patients receiving primary percutaneous coronary intervention with or without remote conditioning (per-protocol analysis)**

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European Heart Journal
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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

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Cardioprotective Role of Remote Ischemic Periconditioning in Primary Percutaneous Coronary Intervention

Enhancement by Opioid Action

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Melissia and Athens, Greece

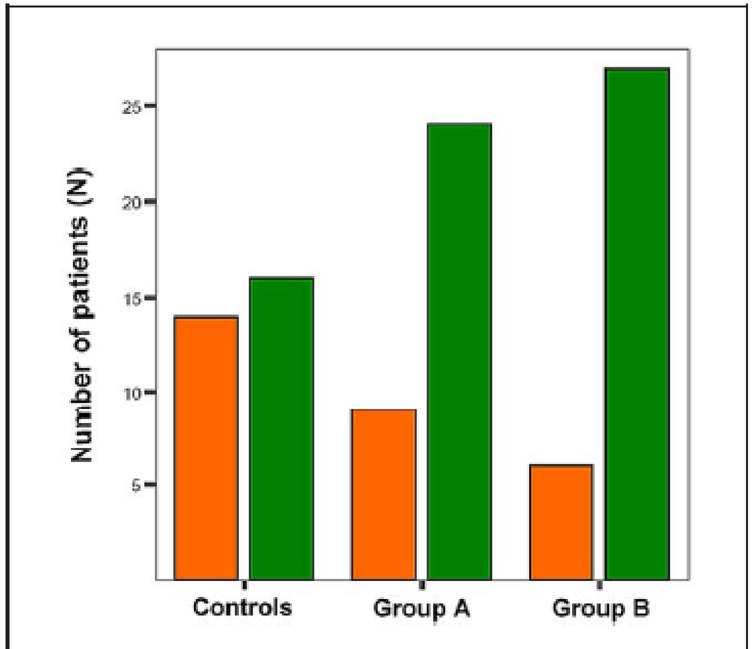

Figure 2. Primary End Point Achievement per Group

Number of patients showing full resolution (≥80%) of ST-segment deviation after percutaneous coronary intervention in each randomization group. The difference was significant for both Groups A and B, when compared to the control group ($p = 0.045$ in the Kruskal-Wallis test; $p = 0.015$ in the Jonckheere-Terpstra test). Slightly more patients in Group B than in Group A achieved full resolution, but the difference between these 2 groups was insignificant. Resolution of ST-segment changes: **orange bars** = incomplete resolution; **green bars** = full resolution.

Resuscitation 85 (2014) 1647–1653

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Resuscitation

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Clinical Paper

Feasibility study of immediate pharyngeal cooling initiation in cardiac arrest patients after arrival at the emergency room☆

Yoshimasa Takeda[a,*], Takahisa Kawashima[b], Kazuya Kiyota[c], Shigeto Oda[d], Naoki Morimoto[e], Hitoshi Kobata[f], Hisashi Isobe[g], Mitsuru Honda[h], Satoshi Fujimi[i], Jun Onda[j], Seishi I[k], Tetsuya Sakamoto[l], Masami Ishikawa[m], Hiroshi Nakano[n], Daikai Sadamitsu[o], Masanobu Kishikawa[p], Kosaku Kinoshita[q], Tomoharu Yokoyama[r], Masahiro Harada[s], Michio Kitaura[t], Kiyoshi Ichihara[u], Hiroshi Hashimoto[v], Hidekazu Tsuji[v], Takashi Yorifuji[w], Osamu Nagano[x], Hiroshi Katayama[y], Yoshihito Ujike[z], Kiyoshi Morita[aa]

Resuscitation 85 (2014) 702–704

Contents lists available at ScienceDirect

Resuscitation

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

Short communication

Chest compressions may be safe in arresting patients with left ventricular assist devices (LVADs)☆

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Resuscitation

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ELSEVIER

Clinical Paper

Extracorporeal life support as rescue strategy for out-of-hospital and emergency department cardiac arrest

Nicholas J. Johnson[a,f,*], Michael Acker[c], Cindy H. Hsu[a], Nimesh Desai[c], Prashanth Vallabhajosyula[c], Sofiane Lazar[c], Jiri Horak[d], Joyce Wald[e], Fenton McCarthy[c], Eduardo Rame[d], Kathryn Gray[a,b,c,d,e], Sarah M. Perman[a,b], Lance Becker[a,b], Doreen Cowie[c], Anne Grossestreuer[b], Tom Smith[c], David F. Gaieski[a,b]

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Cardiac arrest

ABSTRACT

Background: Extracorporeal life support (ECLS) has been utilized as a rescue strategy for patients with cardiac arrest unresponsive to conventional cardiopulmonary resuscitation.
Objective: We sought to describe our institution's experience with implementation of ECLS for out-of-hospital and emergency department (ED) cardiac arrests. Our primary outcome was survival to hospital discharge.
Methods: Consecutive patients placed on ECLS in the ED or within one hour of admission after out-of-hospital or ED cardiac arrest were enrolled at two urban academic medical centers in the United States from July 2007–April 2014.
Results: During the study period, 26 patients were included. Average age was 40 ± 15 years, 54% were male, and 42% were white. Initial cardiac rhythms were ventricular fibrillation or pulseless ventricular tachycardia in 42%. The average time from initial cardiac arrest to initiation of ECLS was 77 ± 51 min (range 12–180 min). ECLS cannulation was unsuccessful in two patients. Eighteen (69%) had complications related to ECLS, most commonly bleeding and ischemic events. Four patients (15%) survived to discharge, three of whom were neurologically intact at 6 months.
Conclusion: ECLS shows promise as a rescue strategy for refractory out-of-hospital or ED cardiac arrest but is not without challenges. Further investigations are necessary to refine the technique, patient selection, and ancillary therapeutics.

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Resuscitation

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

Clinical paper

Emergency physician-initiated extracorporeal cardiopulmonary resuscitation☆

Joseph M. Bellezzo[a,*], Zack Shinar[a,b], Daniel P. Davis[c], Brian E. Jaski[b], Suzanne Chillcott[b], Marcia Stahovich[b], Christopher Walker[b], Sam Baradarian[b], Walter Dembitsky[b]

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Resuscitation
Cardiopulmonary support (CPS)
Extracorporeal life support
Emergency department
Emergency physician

ABSTRACT

Context: Extracorporeal cardiopulmonary resuscitation (ECPR) refers to emergent percutaneous veno-arterial cardiopulmonary bypass to stabilize and provide temporary support of patients who suffer cardiopulmonary arrest. Initiation of ECPR by emergency physicians with meaningful long-term patient survival has not been demonstrated.
Objective: To determine whether emergency physicians could successfully incorporate ECPR into the resuscitation of patients who present to the emergency department (ED) with cardiopulmonary collapse refractory to traditional resuscitative efforts.
Design: A three-stage algorithm was developed for ED ECPR in patients meeting inclusion/exclusion criteria. We report a case series describing our experience with this algorithm over a 1-year period.
Results: 42 patients presented to our ED with cardiopulmonary collapse over the 1-year study period. Of these, 18 patients met inclusion/exclusion criteria for the algorithm. 8 patients were admitted to the hospital after successful ED ECPR and 5 of those patients survived to hospital discharge neurologically intact. 10 patients were not started on bypass support because either their clinical conditions improved or resuscitative efforts were terminated.
Conclusion: Emergency physicians can successfully incorporate ED ECPR in the resuscitation of patients who suffer acute cardiopulmonary collapse. More studies are necessary to determine the true efficacy of this therapy.

Cardiopulmonary resuscitation with assisted extracorporeal life-support versus conventional cardiopulmonary resuscitation in adults with in-hospital cardiac arrest: an observational study and propensity analysis

Yih-Sharng Chen*, Jou-Wei Lin*, Hsi-Yu Yu, Wen-Je Ko, Jih-Shuin Jerng, Wei-Tien Chang, Wen-Jone Chen, Shu-Chien Huang, Nai-Hsin Chi, Chih-Hsien Wang, Li-Chin Chen, Pi-Ru Tsai, Sheoi-Shen Wang, Juey-Jen Hwang, Fang-Yue Lin

Lancet 2008; 372: 554–61

Published Online July 7, 2008 DOI:10.1016/S0140-6736(08)60958-7

See Comment page 512

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Summary

Background Extracorporeal life-support as an adjunct to cardiac resuscitation has shown encouraging outcomes in patients with cardiac arrest. However, there is little evidence about the benefit of the procedure compared with conventional cardiopulmonary resuscitation (CPR), especially when continued for more than 10 min. We aimed to assess whether extracorporeal CPR was better than conventional CPR for patients with in-hospital cardiac arrest of cardiac origin.

Methods We did a 3-year prospective observational study on the use of extracorporeal life-support for patients aged 18–75 years with witnessed in-hospital cardiac arrest of cardiac origin undergoing CPR of more than 10 min compared with patients receiving conventional CPR. A matching process based on propensity-score was done to equalise potential prognostic factors in both groups, and to formulate a balanced 1:1 matched cohort study. The primary endpoint was survival to hospital discharge, and analysis was by intention to treat. This study is registered with ClinicalTrials.gov, number NCT00173615.

Findings Of the 975 patients with in-hospital cardiac arrest events who underwent CPR for longer than 10 min, 113 were enrolled in the conventional CPR group and 59 were enrolled in the extracorporeal CPR group. Unmatched patients who underwent extracorporeal CPR had a higher survival rate to discharge (log-rank $p<0\cdot0001$) and a better 1-year survival than those who received conventional CPR (log rank $p=0\cdot007$). Between the propensity-score matched groups, there was still a significant difference in survival to discharge (hazard ratio [HR] 0·51, 95% CI 0·35–0·74, $p<0\cdot0001$), 30-day survival (HR 0·47, 95% CI 0·28–0·77, $p=0\cdot003$), and 1-year survival (HR 0·53, 95% CI 0·33–0·83, $p=0\cdot006$) favouring extracorporeal CPR over conventional CPR.

Interpretation Extracorporeal CPR had a short-term and long-term survival benefit over conventional CPR in patients with in-hospital cardiac arrest of cardiac origin.

Funding National Science Council, Taiwan.

Introduction

Sudden cardiac arrest still has a low survival rate despite the introduction of cardiopulmonary resuscitation (CPR),[1] and this rate has remained unchanged since 1993.[2,3] Investigations have also shown that survival rate

received CPR of more than 10 min. We also aimed to assess whether the survival benefit of extracorporeal CPR over conventional CPR seen in previous studies[7-9] might have been due to selection bias.

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http://www.j-circ.or.jp

Early Induction of Hypothermia During Cardiac Arrest Improves Neurological Outcomes in Patients With Out-of-Hospital Cardiac Arrest Who Undergo Emergency Cardiopulmonary Bypass and Percutaneous Coronary Intervention

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Yoshiteru Tominaga, MD*; Katsushige Tada, MD*; Mitsuru Ishii, MD*;
Nobutaka Chiba, MD*; Asuka Kasai, MD*; Taketomo Soga, MD*;
Masakazu Matsuzaki, MD; Kei Nishikawa, MD*; Yutaka Tateda, MD*;
Harumi Ikeda, MD*; Tsukasa Yagi, MD

Background: Therapeutic hypothermia for comatose survivors of out-of-hospital cardiac arrest has demonstrated neurological benefits. Although early cooling during cardiac arrest enhances efficacy in animal studies, few clinical studies are available.

Methods and Results: The 171 patients who failed to respond to conventional cardiopulmonary resuscitation were studied prospectively. Patients underwent emergency cardiopulmonary bypass (CPB) plus intra-aortic balloon pumping, with subsequent percutaneous coronary intervention (PCI) if needed. Mild hypothermia (34°C for 3 days) was induced during cardiac arrest or after return of spontaneous circulation. Of the 171 patients, 21 (12.3%) had a favorable neurological outcome at hospital discharge. An unadjusted rate of favorable outcome decreased in a stepwise fashion for increasing quartiles of collapse-to-34°C interval (P=0.016). An adjusted odds ratio for favorable outcome after collapse-to-CPB interval was 0.89 (95% confidence interval (CI) 0.82–0.97) and after CPB-to-34°C interval, 0.99 (95%CI 0.98–0.99) when collapse-to-34°C interval was divided into 2 components. Favorable neurological accuracy of a collapse-to-CPB interval at a cutoff of 55.5 min and CPB-to-34°C interval at a cutoff of 21.5 min was 85.4% and 89.5%, respectively.

Conclusions: Early attainment of a core temperature had neurological benefits for patients with out-of-hospital cardiac arrest who underwent CPB and PCI.

Key Words: Cardiac arrest; Cardiopulmonary bypass; Cardiopulmonary resuscitation; Extracorporeal circulation; Hypothermia

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Resuscitation

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

Clinical paper

Safety and feasibility of prehospital extra corporeal life support implementation by non-surgeons for out-of-hospital refractory cardiac arrest☆

Lionel Lamhaut[a,b,*], Romain Jouffroy[a], Michaela Soldan[a], Pascal Phillipe[a], Thibaut Deluze[a], Murielle Jaffry[a], Christelle Dagron[a], Benoit Vivien[a], Christian Spaulding[b,c], Kim An[a], Pierre Carli[a,b]

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A B S T R A C T

Background: Extra corporeal life support (ECLS) has been recently introduced in the treatment of refractory cardiac arrest (CA). Several studies have assessed the use of ECLS in refractory CA once the patients reach hospital. The time between CA and the implementation of ECLS is a major prognostic factor for survival. The main predictive factor for survival is ECLS access time. Pre hospital ECLS implementation could reduce access time. We therefore decided to assess the feasibility and safety of prehospital ECLS implementation (PH-ECLS) in a pilot study.

Methods and results: From January 2011 to January 2012, PH-ECLS implementation for refractory CA was performed in 7 patients by a PH-ECLS team including emergency and/or intensivist physicians and paramedics. Patients were included prospectively and consecutively if the following criteria were met: they had a witnessed CA; CPR was initiated within the first 5 min of CA and/or there were signs of life during CPR; an PH-ECLS team was available and absence of severe comorbidities. ECLS flow was established in all patients. ECLS was started 22 min (±6) after the incision, and 57 min (±21) after the onset of advanced cardiovascular life support (ACLS). In one patient, ECLS was stopped for 10 min due to an accidental decannulation. One patient survived without sequelae. Three patients developed brain death.

Conclusions: This pilot study suggests that PH-ECLS performed by non-surgeons is safe and feasible. Further studies are needed to confirm the time saved by this strategy and its potential effect on survival.

G Model
RESUS-5881; No. of Pages 7

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Resuscitation xxx (2014) xxx–xxx

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Resuscitation

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

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RESUSCITATION

Clinical Paper

Extracorporeal cardiopulmonary resuscitation versus conventional cardiopulmonary resuscitation in adults with out-of-hospital cardiac arrest: A prospective observational study☆

Tetsuya Sakamoto, Naoto Morimura*, Ken Nagao, Yasufumi Asai, Hiroyuki Yokota, Satoshi Nara, Mamoru Hase, Yoshio Tahara, Takahiro Atsumi, SAVE-J Study Group[1]

The Japanese Scientific Research Group of the Ministry of Health, Labour and Welfare for Extracorporeal Cardiopulmonary Resuscitation: Study of Advanced Cardiac Life Support for Ventricular Fibrillation with Extracorporeal Circulation in Japan (SAVE-J), Japan

ARTICLE INFO

Article history:

ABSTRACT

Background: A favorable neurological outcome is likely to be achieved in out-of-hospital cardiac arrest

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ELSEVIER

Clinical Paper

Refractory cardiac arrest treated with mechanical CPR, hypothermia, ECMO and early reperfusion (the CHEER trial)☆

Q1 Dion Stub[c,f,g], Stephen Bernard[a,b,d,*], Vincent Pellegrino[a], Karen Smith[b,d,e], Tony Walker[d], Jayne Sheldrake[a], Lisen Hockings[a], James Shaw[a,b,c], Stephen J. Duffy[a,b,c], Aidan Burrell[a,b], Peter Cameron[a,b], De Villiers Smit[a], David M. Kaye[a,b,c]

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EMERGENCY MEDICAL SERVICES/ORIGINAL RESEARCH

Statewide Regionalization of Postarrest Care for Out-of-Hospital Cardiac Arrest: Association With Survival and Neurologic Outcome

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Sodium nitroprusside enhanced cardiopulmonary resuscitation improves survival with good neurological function in a porcine model of prolonged cardiac arrest*

Demetris Yannopoulos, MD; Timothy Matsuura, BS; Jason Schultz, MD; Kyle Rudser, PhD; Henry R. Halperin, MD; Keith G. Lurie, MD

Objective: To assess the effectiveness of sodium nitroprusside (SNP)-"enhanced" cardiopulmonary resuscitation (SNPeCPR) on 24-hr survival rates compared to standard CPR in animals after cardiac arrest. SNPeCPR consists of large intravenous SNP bolus doses during CPR enhanced by active compression-decompression CPR, an inspiratory impedance threshold device (ITD), and abdominal binding (AB). The combination of active compression-decompression CPR+ITD+AB *without SNP* will be called "enhanced" or eCPR.

Design: Randomized, blinded, animal study.

Setting: Preclinical animal laboratory.

Subjects: Twenty-four female farm pigs (30 ± 1 kg).

Interventions: Isoflurane anesthetized and intubated pigs were randomized after 8 mins of untreated ventricular fibrillation to receive either standard CPR (n = 8), SNPeCPR (n = 8), or eCPR (n = 8) for 25 mins followed by defibrillation.

Measurements and Main Results: The primary end point was carotid blood flow during CPR and 24-hr survival with good neurologic function defined as an overall performance category score of ≤2 (1 = normal, 5 = brain dead or dead). Secondary end points included hemodynamics and end-tidal CO_2. SNPeCPR significantly improved carotid blood flow and 24-hr survival rates with good neurologic function compared to standard CPR or eCPR (six of eight vs. zero of eight vs. one of eight, $p < .05$). The improved survival rates were associated with higher coronary perfusion pressure and $ETco_2$ during CPR.

Conclusion: In pigs, SNPeCPR significantly improved hemodynamics, resuscitation rates, and 24-hr survival rates with good neurologic function after cardiac arrest when compared with standard CPR or eCPR alone. (Crit Care Med 2011; 39:1269–1274)

KEY WORDS: vasodilators; cardiopulmonary resuscitation; neurological function; resuscitation rates; carotid blood flow

Yannopoulos, Matsuura, Schultz, et al. Crit Care Med. 2011 Feb 24.

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Resuscitation

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

Sodium nitroprusside enhanced cardiopulmonary resuscitation prevents post-resuscitation left ventricular dysfunction and improves 24-hour survival and neurological function in a porcine model of prolonged untreated ventricular fibrillation

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A R T I C L E   I N F O

Keywords:
Cardiopulmonary resuscitation
Left ventricular function
Neurological function
Survival
Vasodilation

A B S T R A C T

Aim of study: Sodium nitroprusside-enhanced CPR, or SNPeCPR, consists of active compression-decompression CPR with an impedance threshold device, abdominal compression, and intravenous sodium nitroprusside (SNP). We hypothesize that SNPeCPR will improve post resuscitation left ventricular function and neurological function compared to standard (S) CPR after 15 min of untreated ventricular fibrillation in a porcine model of cardiac arrest.
Methods: Pigs ($n = 22$) anesthetized with isoflurane underwent 15 min of untreated ventricular fibrillation, were then randomized to 6 min of S-CPR ($n = 11$) or SNPeCPR ($n = 11$) followed by defibrillation. The primary endpoints were neurologic function as measured by cerebral performance category (CPC) score and left ventricular ejection fraction.
Results: SNPeCPR increased 24-hour survival rates compared to S-CPR (10/11 versus 5/11, $p = 0.03$) and improved neurological function (CPC score 2.5 ± 1, versus 3.8 ± 0.4, respectively, $p = 0.004$). Left ventricular ejection fractions at 1, 4 and 24 hours after defibrillation were 72 ± 11, 57 ± 11.4 and 64 ± 11 with SNPeCPR versus 29 ± 10, 30 ± 17 and 39 ± 6 with S-CPR, respectively ($p < 0.01$ for all).
Conclusions: In this pig model, after 15 min of untreated ventricular fibrillation, SNPeCPR significantly improved 24-hour survival rates, neurologic function and prevented post-resuscitation left ventricular dysfunction compared to S-CPR.

Sequential Invasive Resuscitation Interventions in Medical/Non-Trauma Cardiac Arrest

If initial CPR, Defibrillation, ACLS is unsuccessful (No ROSC)

Femoral artery SAAP balloon catheter insertion & initiate SAAP with O_2 carrier (HBOC, PFC, WB/pRBC)
(obtain venous access during this initial SAAP phase)

If ROSC not achieved, **venous blood W/D & transition to SAAP with Autologous Blood (partial ECMO/ECLS)**

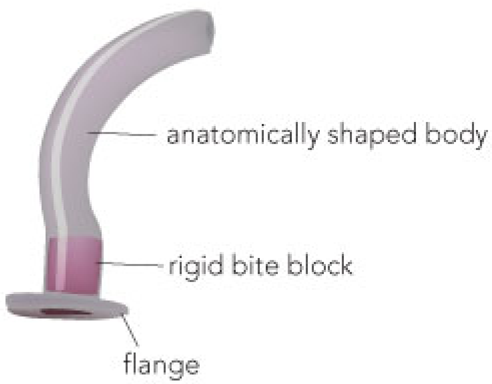
If ROSC not achieved, **larger femoral arterial cannula & convert to whole body ECLS/ECPR**

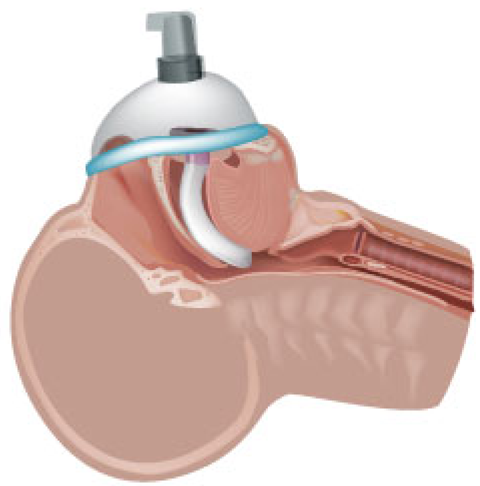
If ROSC not achieved, **Consider: Cardiac Cath for PCI, LVAD, VIR, CT/Vasc Surgery, profound hypothermia (?), and cessation of resuscitation efforts**

http://emcrit.org/podcasts/selective-aortic-arch-perfusion/

The Bottom Line - Airway

- Delay definitive airway management until after ROSC
    - DO NOT stop compressions for airway
        - BVM (+) OPA may be superior





http://www.atitesting.com/ati_next_gen/skillsmodules/content/airway-management/equipment/devices.html

The Bottom Line - Breathing

- Use low tidal volumes
- Use RR of 6 – 10
- Can use ventilator
- ITD
- DO NOT STOP COMPRESSIONS FOR VENTILATION

The Bottom Line - Circulation

- Minimize time off chest ratio - > 80%
- Only hands off time is for defibrillation (maybe) and rhythm analysis
- CHARGE DEFIB PRIOR TO RHYTHM ANALYSIS
- Use End-Tidal CO_2 to guide compression quality
- Treat refractory VF with DSED or beta blockade
- Target a diastolic BP > 25 mm hg with vasopressors
- Mechanical CPR in ambulance and cath lab
- Immediate CPR post shock
- “Consider” drugs
- ECMO

The Bottom Line – Post-Arrest

- Therapeutic hypothermia
- STRONGLY consider cath lab for OOHCA
- Maintain hemodynamics
- Sedate
- CANNOT PROGNOSTICATE ANYONE