Emergency Department and EMS Management Perspective from the Experts

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Objectives

1. Review the steps to be followed for field resuscitation for patients who may be candidates for therapeutic hypothermia.
2. List the basic steps for ED codes for patients who may be candidates for therapeutic hypothermia.
3. Outline the collaboration between the Emergency Department, Intensive Care Unit and Cardiology needed to treat cardiac arrests.
4. Describe strategies to engage the community as the first line of defense for cardiac emergencies.

- What is A Cardiac Resuscitation System of Care?
- How Can I Improve Field Care for Patients with Out-of-Hospital Cardiac Arrest?
- Should I Encourage My EMS System to Start Hypothermia in the Field?

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- How Should I Manage Cardiogenic Shock in Patients Resuscitated from Cardiac Arrest?
- What is the Role of CT Head Scans in Patients Resuscitated from Cardiac Arrest?
- When and How Can I Assess Prognosis in Patients Resuscitated from Cardiac Arrest?
- Are there clinical indicators to help with the decision about which patients should not be cooled?

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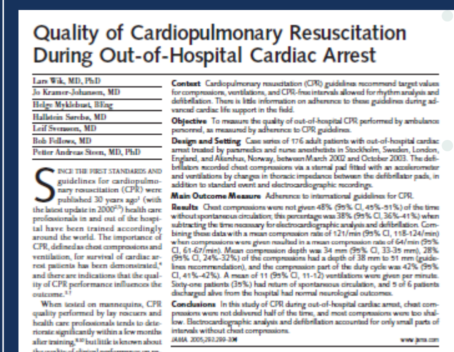
MHI @ Abbott Northwestern Hospital

- EMS
- Emergency Dept Physician
- Intensivists
- Cardiologist
- Nursing
- Educators
- Operational Sub Committee

Cardiac Arrest in the Field

- What's the best care?
  - Mechanical Compression
  - Cooling
- What is the best location to take the patient?
  - Nearest facility or most able facility?

Mechanical Compression



Quality of Cardiopulmonary Resuscitation During Out-of-Hospital Cardiac Arrest

Lars Wik, MD, PhD
Jo Kramer-Johansen, MD
Helge Myklebust, BEng
Hallstein Sørebø, MD
Leif Svensson, MD
Bob Fellows, MD
Petter Andreas Steen, MD, PhD

Context Cardiopulmonary resuscitation (CPR) guidelines recommend target values for compressions, ventilations, and CPR-free intervals allowed for rhythm analysis and defibrillation. There is little information on adherence to these guidelines during advanced cardiac life support in the field.

Objective To measure the quality of out-of-hospital CPR performed by ambulance personnel, as measured by adherence to CPR guidelines.

Design and Setting Case series of 176 adult patients with out-of-hospital cardiac arrest treated by paramedics and nurse anesthetists in Stockholm, Sweden, London, England, and Akershus, Norway, between March 2002 and October 2003. The defibrillators recorded chest compressions via a sternal pad fitted with an accelerometer and ventilations by changes in thoracic impedance between the defibrillator pads, in addition to standard event and electrocardiographic recordings.

Main Outcome Measure Adherence to international guidelines for CPR.

Results Chest compressions were not given 48% (95% CI, 45%-51%) of the time without spontaneous circulation; this percentage was 38% (95% CI, 36%-41%) when subtracting the time necessary for electrocardiographic analysis and defibrillation. Combining these data with a mean compression rate of 121/min (95% CI, 118-124/min) when compressions were given resulted in a mean compression rate of 64/min (95% CI, 61-67/min). Mean compression depth was 34 mm (95% CI, 33-35 mm), 28% (95% CI, 24%-32%) of the compressions had a depth of 38 mm to 51 mm (guidelines recommendation), and the compression part of the duty cycle was 42% (95% CI, 41%-42%). A mean of 11 (95% CI, 11-12) ventilations were given per minute. Sixty-one patients (35%) had return of spontaneous circulation, and 5 of 6 patients discharged alive from the hospital had normal neurological outcomes.

Conclusions In this study of CPR during out-of-hospital cardiac arrest, chest compressions were not delivered half of the time, and most compressions were too shallow. Electrocardiographic analysis and defibrillation accounted for only small parts of intervals without chest compressions.

JAMA. 2005;293:299-304 www.jama.com

SINCE THE FIRST STANDARDS AND guidelines for cardiopulmonary resuscitation (CPR) were published 30 years ago[1] (with the latest update in 2000[2,3]) health care professionals in and out of the hospital have been trained accordingly around the world. The importance of CPR, defined as chest compressions and ventilation, for survival of cardiac arrest patients has been demonstrated,[4] and there are indications that the quality of CPR performance influences the outcome.[5-7]

When tested on mannequins, CPR quality performed by lay rescuers and health care professionals tends to deteriorate significantly within a few months after training,[8-10] but little is known about the quality of clinical performance on pa-

- Compressions not given 50% of the time.
- Not attributed to ECG assessment or other expected interruptions

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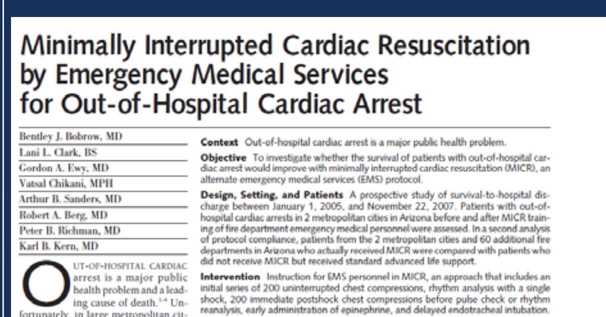
Compression Only CPR or CCR



Minimally Interrupted Cardiac Resuscitation by Emergency Medical Services for Out-of-Hospital Cardiac Arrest

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Vatsal Chikani, MPH
Arthur B. Sanders, MD
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Karl B. Kern, MD

Context Out-of-hospital cardiac arrest is a major public health problem.

Objective To investigate whether the survival of patients with out-of-hospital cardiac arrest would improve with minimally interrupted cardiac resuscitation (MICR), an alternate emergency medical services (EMS) protocol.

Design, Setting, and Patients A prospective study of survival-to-hospital discharge between January 1, 2005, and November 22, 2007. Patients with out-of-hospital cardiac arrests in 2 metropolitan cities in Arizona before and after MICR training of fire department emergency medical personnel were assessed. In a second analysis of protocol compliance, patients from the 2 metropolitan cities and 60 additional fire departments in Arizona who actually received MICR were compared with patients who did not receive MICR but received standard advanced life support.

Intervention Instruction for EMS personnel in MICR, an approach that includes an initial series of 200 uninterrupted chest compressions, rhythm analysis with a single shock, 200 immediate postshock chest compressions before pulse check or rhythm reanalysis, early administration of epinephrine, and delayed endotracheal intubation.

Main Outcome Measure Survival-to-hospital discharge.

OUT-OF-HOSPITAL CARDIAC arrest is a major public health problem and a leading cause of death.[1-4] Unfortunately, in large metropolitan cit-

- Survival increased from 1.8% to 5.4%

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Prehospital Hypothermia

Arrhythmia/Electrophysiology

Hypothermia Improves Defibrillation Success and Resuscitation Outcomes From Ventricular Fibrillation

Kimberly A. Boddicker, MD; Yi Zhang, MD, PhD; M. Bridget Zimmerman, PhD; Loyd R. Davies, BS; Richard E. Kerber, MD

- Early is better
- This study showed improved rates of defibrillation success in patients with reduced temperatures.

Where is the correct destination

- Spaite et al. Resuscitation 2008
- "The impact of prehospital transport interval on survival in out-of-hospital cardiac arrest: Implications for regionalization of post-resuscitation care"

- No significant difference in outcome based on transport time.

Creating a Heart Safe Community

Kim Bemenderfer
Heart Safe Coordinator

What is HEART SAFE COMMUNITIES?

A community benefit program of Allina Hospitals & Clinics; created in 2001 at Allina Medical Transportation to assist communities and organizations in implementing wide spread CPR training and assisting with AED placement in places where people live, work and play.

What can Heart Safe do?

- AED Awareness & Placement
- AED Maintenance
- SCA Survivor Partnership
- CPR Training
- Community and organization planning and designation as "Heart Safe"
- Heart Health Activities – such as Heart Walk, Take Heart, Heart of New Ulm
- Nutritional Activities – such as healthy vending machine items
- Physical Activity Programs – such as Power by the Hour

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Things we have done:

- Placement of over 1200 AEDs in organizations and communities
- Mass CPR Training with Medtronic Grant
- Placement of AEDs with Employee Giving Dollars in Allina communities
- Celebrate Survivors with Events
- Involvement in Take Heart Anoka County project to implement training programs at schools and local Fire Departments
- Placement of AEDs and Wide spread CPR training through Take Heart Anoka County

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How is Heart Safe involved with the Take Heart Initiative?

Take Heart America coordinates what Heart Safe and Allina Hospitals & Clinics are doing, what the AHA recommends and what SCA victims need…

- Early Bystander CPR & AED placement
- Quality CPR and new circulation enhancement devices by rescuers
- AED
- Improved drug delivery
- After resuscitation: specialized care including cooling, blockage removal and implantable defibrillator

What is a *HEART SAFE COMMUNITY*?

An organization or geographic area that has embraced the concepts of encouraging prevention and heart health; has assessed the needs and developed plans to implement wide spread CPR training and AED placement; and engages in activities that create awareness of Healthy Heart Living and CPR/AED use.

HEART SAFE Concepts

Sudden Cardiac Arrest Awareness

- Presentations
- Partnerships with SCA Survivors
- Heart Safe Dinner to celebrate and recognize survivors
- Community Designation

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HEART SAFE Concepts

AED Placement

- Business, schools, and many others
- AED training and information
- Grants for placement

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HEART SAFE Concepts

CPR Training

- New concepts in training – simple, short and customized
- CPR Anytime Training
- You Tube – ‘No Fear CPR’
- School curriculum

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More Information:

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First Steps in Resuscitation Field to Emergency Department

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Disclosures

- NHLBI, Bethesda, MD; Co-PI, Resuscitation Outcomes Consortium Data Coordinating Center.
- NHLBI, Bethesda, MD; PI, Randomized Trial of Hemofiltration After Resuscitation from Cardiac Arrest.
- NHLBI, Bethesda, MD; Co-I, Randomized Field Trial of Cold Saline IV After Resuscitation from Cardiac Arrest.
- Asmund S. Laerdal Foundation for Acute Medicine Stavanger, NO; PI, Randomized Trial of CPR Training Aid in Community.
- Medtronic Foundation, Minneapolis, MN; PI, Cascade HeartRescue Program.
- Sotera Wireless, San Diego, CA; Research Collaborator.
- Gambro Renal Inc., Denver, CO; Research Collaborator.
- Lifebridge North America Inc., San Antonio, TX; Research Collaborator.
- American Heart Association, Dallas, TX; Travel Expenses.

What Is A Cardiac Resuscitation System of Care?

System

Meadows Thinking in Systems 2008

- **Interconnected** set of **elements** that is coherently organized in a way that **achieves** something.

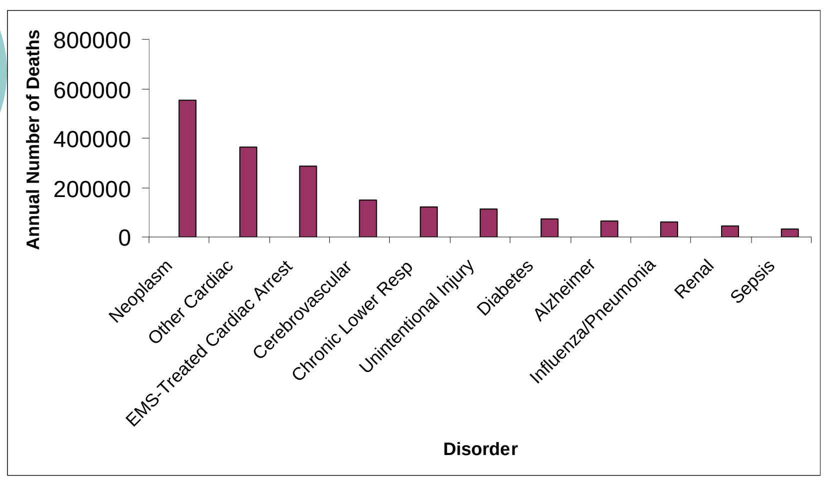
Cardiac Resuscitation System of Care

Nichol Circulation 2010

- **Interconnectedcommunity, EMS and hospital** response to out-of-hospital cardiac arrest that is coherently organized to **improve processes and outcome** in a **region**.

Leading Causes of Death in U.S

Extrapolated from www.cdc.gov and Nichol JAMA 2008



EMS-Assessed Cardiac Arrest

Nichol JAMA 2008

	Alabama (n=715)	Dallas (n=2,462)	Iowa (n=1,028)	Ottawa (n=2,965)	Pittsburg h (n=1,217)	Portland (n=1,320)	Seattle and KC (n=2,349)	Toronto (n=5,155)	Vancouve r (n=2,373)	Overall(n =19,584)
Incidence , per 100,000	106.7	159.0	93.1	71.8	105.1	77.5	144.0	96.8	75.9	95.0
Survival, %	1.1	2.4	6.1	3.3	3.3	6.5	8.1	3.2	6.7	4.4
Missing VS, %	2.0	1.5	1.2	0.7	0.3	1.5	0.1	0.4	1.2	0.8

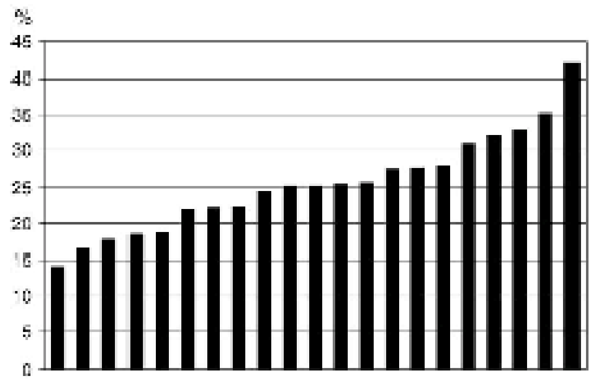
Ventricular Fibrillation

Nichol JAMA 2008

	Alabama (n=267)	Dallas (n=1,265)	Iowa (n=565)	Milwauke e (n=801)	Ottawa (n=1,836)	Pittsburg h (n=575)	Portland (n=793)	Seattle and KC (n=1,170)	Toronto (n=2,992)	Vancouve r (n=1,634)	Overall (n=1189 8)
Incidence , per 100,000	9.9	12.8	12.4	18.7	10.4	9.3	15.1	19.0	11.4	15.2	12.8
Survival, %	7.7	9.5	22.7	26.0	14.8	21.5	22.5	39.9	15.7	25.0	21.0
Missing VS, %	3.1	7.9	4.4	0	2.1	1.0	3.6	0.3	1.3	3.3	2.5

Survival from Admission to One Month

Herlitz Resuscitation 2006



- Out-of-hospital cardiac arrest is major public health problem.
- Large variation in survival.
- Treatable condition.

Wake County, NC

Hinchey Ann Emerg Med 2010

- Multiphase before-after study
  - Baseline
    - C:V ratio 15:2
    - Stacked shocks
  - “New” CPR
    - Early intubation deemphasized
    - Minimal interruption in compressions
    - Single defibrillation
    - Control of ventilation rates
    - Intraosseous
  - Impedance threshold device
  - Field hypothermia

Wake County, NC

HincheyAnn Emerg Med 2010

Characteristics	Baseline (N=425)	Phase 1 (N=369)	Phase 2 (N=161)	Phase 3 (N=410)	Absolute Increase* % (95% CI)
Survival outcome					
Any ROSC	105 (24.7)	148 (40.1)	66 (41.0)	178 (43.4)	18.7 (12.4 to 25.0)
Pulse on ED arrival	98 (23.1)	136 (36.9)	52 (32.3)	138 (33.7)	10.6 (4.5 to 16.7)
Admitted to hospital	55 (12.9)	65 (17.6)	31 (19.3)	121 (29.5)	16.6 (11.2 to 22.0)
Discharged from hospital	18 (4.2)	27 (7.3)	13 (8.1)	47 (11.5)	7.3 (3.7 to 10.9)
Survivors' CPC score	n=14	n=25	n=12	n=47	
1 and 2	11 (78.6)	19 (76.0)	10 (83.3)	36 (76.6)	−2.0 (−26.6 to 22.7)
3 and 4	3 (21.4)	6 (24.0)	2 (16.7)	11 (23.4)	2.0 (−22.7 to 26.6)

ROSC, Return of spontaneous circulation; *CPC*, cerebral performance category.
All data are presented as No. (%) survivors unless otherwise noted.
*Absolute increase and 95% CI for comparison between baseline and phase 3 (full implementation). CPC 1 and 2 denote "good" and "moderate" cerebral performance; 3 and 4 denote "poor" and "vegetative" cerebral performance; 5 denotes "brain death" and thus is not represented.

Patient Volume vs. Outcome for Cardiac Arrest

Callaway Annals of Emerg Med 2010

Annual Volume	Number of Hospitals	Survival to Discharge (%)	Adjusted Odds of Death (95% CI)
1-9	103	28.7	Reference
10-19	55	30.8	0.85 (0.65, 1.12)
20-29	23	32.6	0.89 (0.65, 1.21)
30-39	11	28.3	1.04 (0.75, 1.45)
≥ 40	11	37.3	0.91 (0.67, 1.25)

Adjusted for patient factors (witnessed collapse, initial rhythm, and age) and hospital factors (cath capability)

Randomized Trials of Regionalized STEMI Care

Adapted from Nichol Circulation 2010

AUTHOR DESIGN	POPULATION	INTERVENTION	COMPARATOR	ALTERNATIVE COMPARATOR
Vermeer Individual randomized trial in 1 province, Netherlands	AMI, presenting at hospitals not capable of PPCI	Transfer for PPCI (n=75) Symptoms to therapy 240 ± NR Door to balloon NR Death[a] 7% Recurrent infarct[a] 1% Stroke[a] 3%	Fibrinolytic in non-PCI hospital (n=75) Symptoms to therapy 135 ± NR Door to balloon NR Death[a] 7% Recurrent infarct[a] 9% Stroke[a] 3%	Fibrinolytic with transfer; rescue PCI if indicated (n=74) Symptoms to therapy 255 ± NR Door to balloon NR Death[a] 8% Recurrent infarct[a] 5% Stroke[a] 4%
Widimsky Individual randomized trial in 1 province, Czech Republic	AMI, presenting within 6 h of symptom onset at hospitals not capable of PPCI	Immediate transfer for PPCI (n=101) Symptoms to therapy 215 ±NR Door to balloon NR Death[b] 7% Recurrent infarct[b] 1% P<0.03 Stroke[b] 0%	Fibrinolytic therapy in non-PCI hospitals (n=99) Symptoms to therapy 132 ± NR Door to balloon NR Death[b] 14% Recurrent infarct[b] 10% Stroke[b] 1%	Fibrinolytic therapy during transport for PCI (n=100) Symptom to therapy 220 ± NR Door to balloon NR Death[b] 12% Recurrent infarct[b] 7% Stroke[b] 3%
Andersen Individual randomized trial in Denmark	AMI with ST elevation presenting at hospital not capable of PPCI	Transfer for angioplasty within 3 h (n=567) Symptoms to therapy227±NR Door to balloon 26 Death[b] 7% Recurrent infarct[b] 2% Stroke[b] 2%	Fibrinolysis at referral hospital (n=562) Symptoms to therapy 150±NR Door to therapy NR Death[b] 9% Recurrent infarct[b] 6% Stroke[b] 2%	N/A

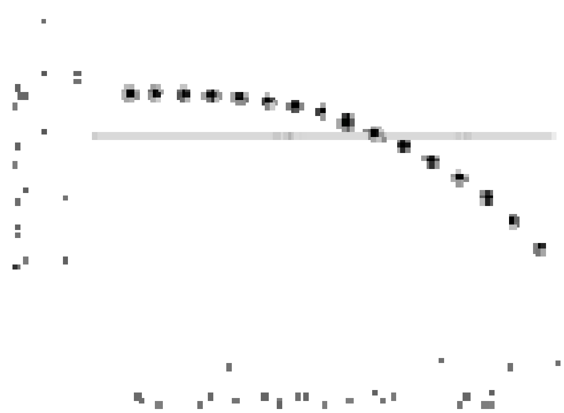
Randomized Trials of Regionalized STEMI Care

(continued)

AUTHOR DESIGN	POPULATION	INTERVENTION	COMPARATOR	ALTERNATIVE COMPARATOR
Grines Individual randomized trial in US and Europe	High-risk AMI with ST elevation or presumed new left bundle branch block <12h	Transfer for PPCI (n=71) Symptoms to therapy NR Door to balloon 174 ± 80 Death[b] 8% Recurrent infarct[b] 1% Stroke[b] 0%	Fibrinolytic therapy (n=66) Symptoms to therapy NR Door to therapy 63 ± 39 Death[b] 12% Recurrent infarct[b] 0% Stroke[b] 4%	N/A
Bonnefoy Individual randomized trial in France	Patients with STEMI presenting to EMS within 6 h of symptom onset	Primary PCI (n=421) Symptoms to therapy NR Death[b] 5% Recurrent infarct[b] 2% Stroke[b] 0%	Prehospital fibrinolysis (n=419) Symptoms to therapy NR Death[b] 4%) Recurrent infarct[b] 4% Stroke[b] 1%	N/A
Widimsky Individual randomized trial in Czech Republic	Patients with STEMI within 12 h of symptom onset presenting to non–PCI-capable hospital	Immediate transfer for primary PCI (n=429) Symptoms to therapy 203 ± NR Death[b] 7% Recurrent infarct[b] 1% Stroke[b] 0%	Fibrinolytic in community hospital (n=421) Symptoms to therapy 185 ± NR Death[b] 10% Recurrent infarct[b] 3% Stroke[b] 2%	N/A

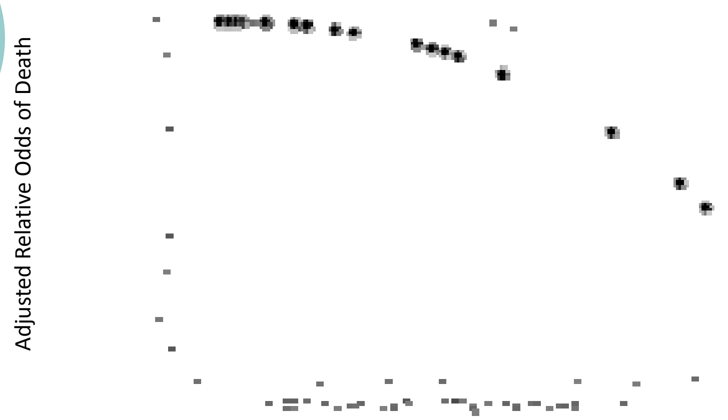
Trauma Systems of Care

Nathens*JAMA* 2001



Trauma Systems of Care

Nathens JAMA 2000



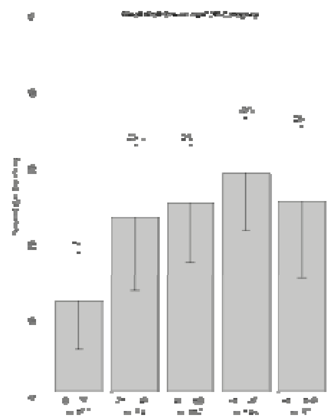
- Direct and indirect evidence that regional cardiac resuscitation systems of care will improve outcome
- Effects
  - Take time to develop
  - Depend on patient volume

How Can We Improve Field Care for Out-of-Hospital Cardiac Arrest?

Improve Manual CPR!

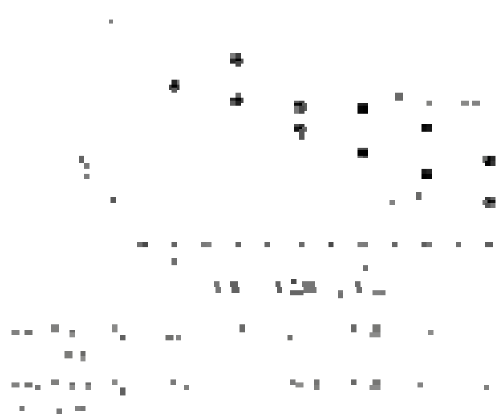
Chest Compression Fraction

Christenson Circulation 2009



CPR Before Rhythm Analysis

Cobb JAMA 1999



CPR Before Rhythm Analysis

Wik JAMA 2003

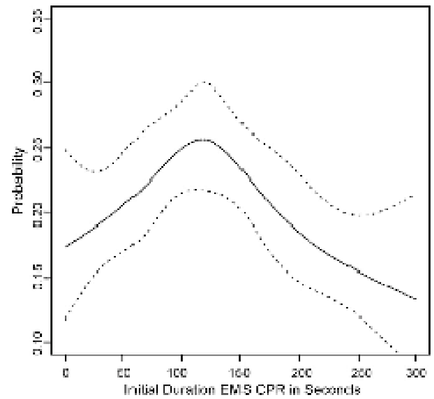
CPR Before Rhythm Analysis

Bradley Resuscitation 2010

Initial CPR duration (s)	≤45	46–75	76–105	106–135	136–165	166–195	196–225	226–255	256–285	286–315
Treated, n	210	277	158	308	203	173	93	105	51	60
Survived to discharge (%)	17.6	23.1	24.7	23.1	26.6	21.4	15.1	15.2	9.8	18.3
Adjusted OR of survival in logistic regression model[a] (95% CI)	Reference	1.15 (0.71, 1.37)	1.37 (0.80, 2.35)	1.53 (0.96, 2.45)	1.24 (0.71, 2.15)	1.47 (0.85, 2.52)	0.95 (0.47, 1.81)	0.91 (0.46, 1.79)	0.46 (0.13, 1.29)	1.29 (0.59, 2.85)
Adjusted OR of survival in random-effects model[a] (95% CI)	Reference	1.19 (0.73, 1.32)	1.43 (0.81, 2.47)	1.54 (0.97, 2.40)	1.34 (0.77, 2.33)	1.47 (0.85, 2.52)	0.98 (0.48, 2.02)	0.93 (0.46, 1.83)	0.47 (0.13, 1.35)	1.30 (0.59, 2.90)

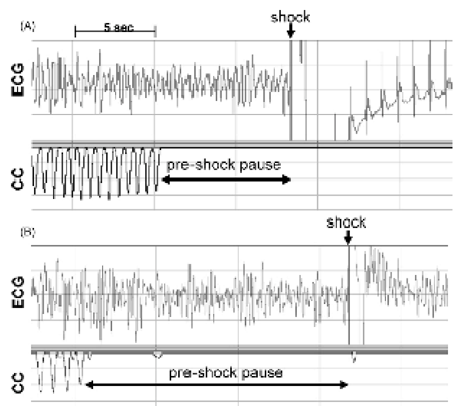
CPR Before Rhythm Analysis

Bradley Resuscitation 2010



Preshock Pause

Edelson Resuscitation 2008



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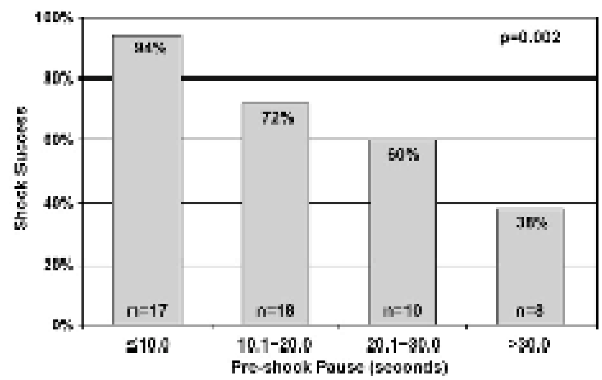
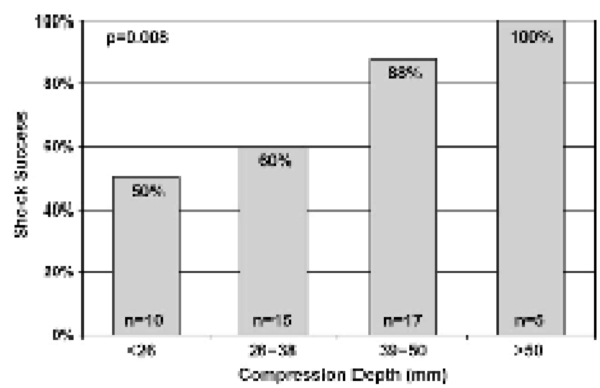


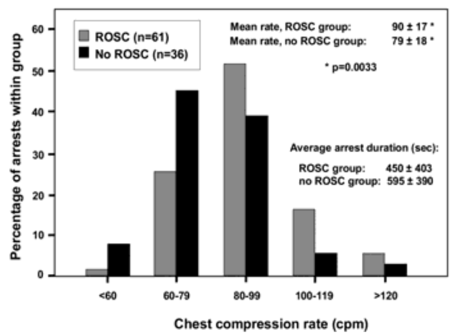
Compression Depth

EdelsonResuscitation 2008



Chest Compression Rate

Abella Circulation 2005



Use Single Rather than Stacked Shocks!

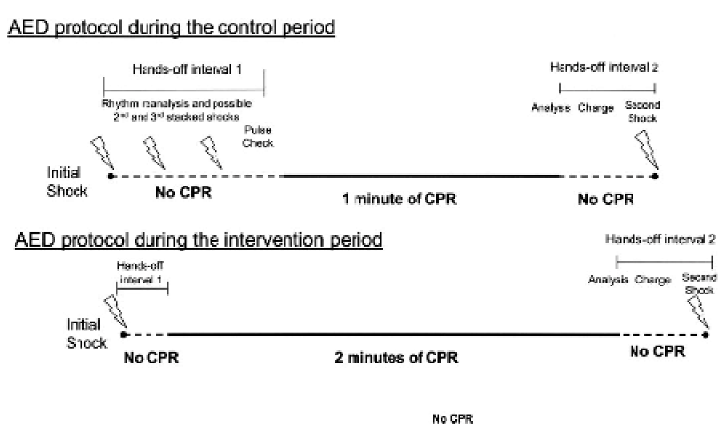
Shock to PerfusingRhythm

SundeResuscitation 1999

- Observational study of out-of-hospital cardiac arrest in Norway (n=156 patients, 883 shocks).
- Pulse generating rhythm regardless of duration after shock:
  - 90 shocks (10%) in 51 patients had any ROSC;
  - 35 (4%) had sustained ROSC after shock;
    - 14 after first shock
    - 2 after second shock
    - 3 after third

Single versus Stacked Shock

Rea Circulation 2006



Single versus Stacked Shock

Rea Circulation 2006

	Control Period [illegible]	[illegible]
Outcome	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
Hospital survival	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

[illegible]

Ignore Manual Compression Devices!

Mechanical Compressions Using Load-Distributing Band Device

Ong JAMA 2006

[illegible]

Of 210 patients in whom LDB device was applied,
38 patients (18.1%) survived to hospital admission (95% CI13.4%, 23.9%)
12 patients (5.7%) survived to hospital discharge (95% CI, 3.0%, 9.3%).

Mechanical Compressions Using Load-Distributing Band Device

Hallstrom JAMA 2006

[illegible]

Mechanical Compressions Using Load-Distributing Band Device

Hallstrom JAMA 2006

	[illegible]			
	Univariable OR (95% CI)	P Value	Multivariable OR (95% CI)	P Value
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
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[illegible]	[illegible]	[illegible]	[illegible]	

Consider Continuous Chest Compressions?

Minimally Interrupted Cardiac Resuscitation

Bobrow *JAMA* 2006

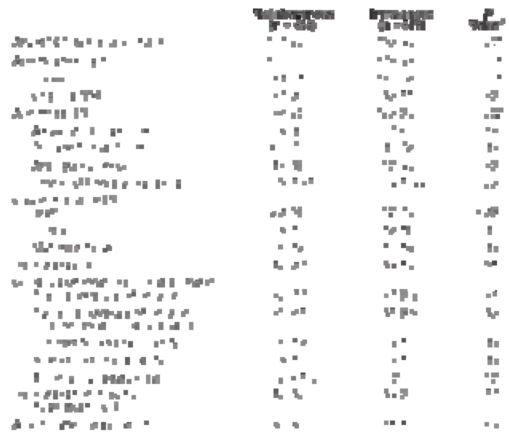
Outcome	No. (%) of Patients		Odds Ratio (95% CI)		Significant Covariates in Final Model
	Before MICR	After MICR	Unadjusted	Adjusted	
[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]					
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

[illegible]

Ignore Intravenous Drugs!

Intravenous Drugs

Olasveengen *JAMA* 2009

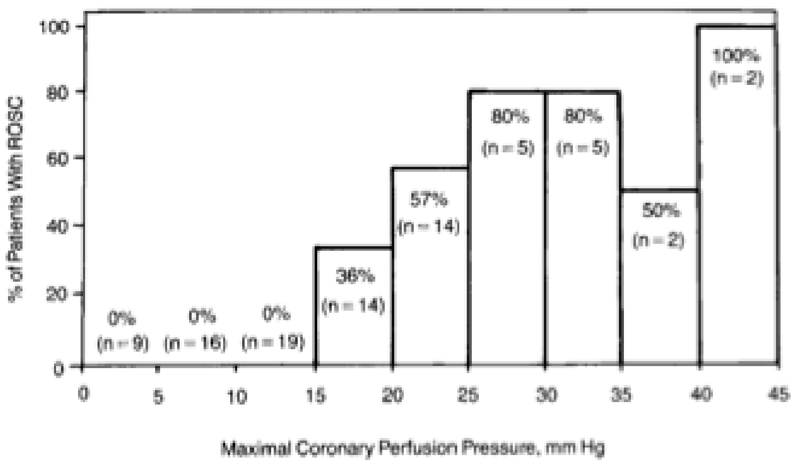


Impedance Threshold Device

Coronary Perfusion Pressure

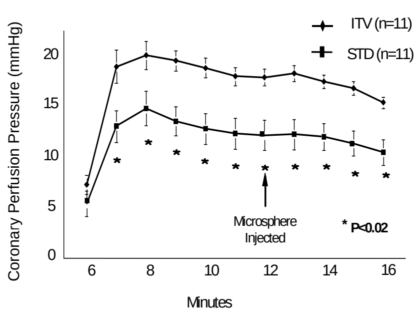
Paradis JAMA 1990

Aortic-to-right atrial pressure gradientduring relaxation phase of cardiopulmonary resuscitation



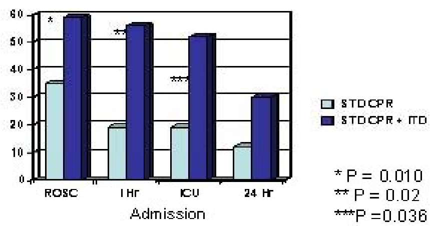
Impedance Threshold Device Improves Coronary Perfusion Pressure

erheide Crit Care Med 2005



Outcomes for Cardiac Arrest with PEA at any time during Resuscitation in Milwaukee Trial

AufderheideCrit Care Med 2005



Post hoc subgroup analysis susceptible to bias

No significant difference btwn CPR and CPR+ITD when adjusted for multiple comparisons

Effect Observed in Blinded vs. Unblinded Trials

BeroPLOS Medicine 2007

[illegible]	[illegible]	[illegible]			[illegible]		
		[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Impact factor	Quartile 1(0.21–1.76)	17/46 (37)	1.00		17/46 (37)	1.00	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Quartile 3 (3.14–3.75)	28/47 (60)	2.5 (1.09–5.8)	0.03	26/47 (55)	2.1(0.92–4.8)	0.08
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Concealment of allocation	Not adequate	70/151 (46)	1.00		71/151 (46)	1.00	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Inclusion of all in analysis	Not adequate	73/146 (50)	1.00		71/146 (49)	1.00	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Blinding	Not adequate	61/103 (59)	1.00		56/103 (54)	1.00	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Sample size	Quartile 1(7–35)	22/49 (45)	1.00		15/49 (45)	1.00	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	Quartile 3 (93–272)	20/48 (42)	0.88 (0.39–1.96)	0.75	19/48 (42)	1.49 (0.64–3.4)	0.36
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
Funding source	Industry	46/95 (48)	1.00		55/95 (58)	1.00	
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	No funding disclosed	38/74 (51)	1.12 (0.61–2.1)	0.71	29/74 (39)	0.47 (0.25–0.87)	0.02

Consider Limiting Oxygenation?

Pilot Randomized Trial of 30% vs. 100% Oxygen After Resuscitation

Kuisma et al Resuscitation 2006

	Group A ($n = 14$)	Group B ($n = 14$)	p
All patients ($n = 28$)			
NSE (μg/l)			
30 min after ROSC	10.5 ± 3.3	9.8 ± 2.3	0.6652
24 h after ROSC	10.9 ± 7.7	13.0 ± 7.3	0.1985
48 h after ROSC	14.2 ± 19.4	18.6 ± 21.0	0.5913
S-100 (μg/l)			
30 min after ROSC	0.79 ± 0.45	1.33 ± 1.31	0.6256
24 h after ROSC	0.21 ± 0.15	0.47 ± 0.79	0.2766
48 h after ROSC	0.23 ± 0.21	0.39 ± 0.43	0.3600
	Group A ($n = 8$)	Group B ($n = 7$)	p
Patients who were not treated with therapeutic hypothermia in hospital ($n = 15$)			
NSE (μg/l)			
30 min after ROSC	10.1 ± 4.0	10.8 ± 2.6	0.8815
24 h after ROSC	7.6 ± 4.2	13.5 ± 9.6	0.0487
48 h after ROSC	7.4 ± 2.9	21.4 ± 25.8	0.4233
S-100 (μg/l)			
30 min after ROSC	0.77 ± 0.51	2.08 ± 1.55	0.1213
24 h after ROSC	0.17 ± 0.05	0.73 ± 1.1	0.2012
48 h after ROSC	0.15 ± 0.08	0.49 ± 0.61	0.3913

Group A was ventilated with 30% oxygen and group B with 100% oxygen.

Quasi Randomized Trial of Oxygen Supplementation in Patients with Stroke

Rønning *Stroke* 1999