Update on Sudden Cardiac Death and Resuscitation

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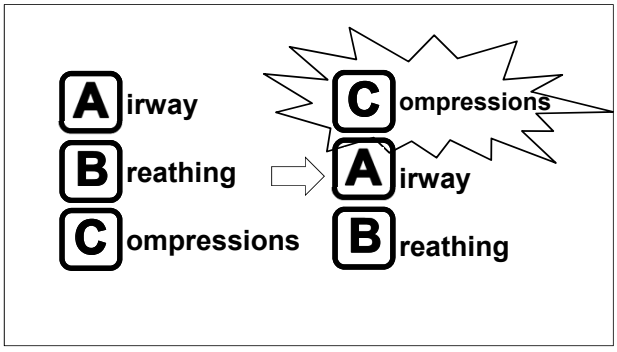
Background

- Cardiac arrest is a significant public health issue with ~326,000 people affected by per year in the US.
- This is 37 people per hour having a cardiac arrest event
- Neurologically intact survival from these events is generally poor and varies based on where someone has an arrest.

Basic concepts we know?

- Early response saves lives
- Early CPR saves lives
- More people performing CPR saves lives
- Good CPR saves lives

Tough decisions…



Overarching Concept

GOAL

Improving outcomes from cardiac arrest

Lesson Learned

It takes a community to save a life.

Story of a Survivor

Links in the Chain

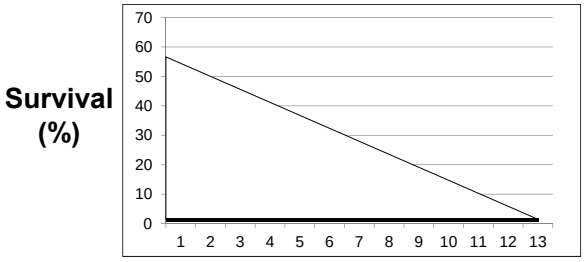
"Emergency systems that can effectively implement these links can achieve witnessed VF cardiac arrest survival greater than 50%"

Outline

- **Review some current data on cardiac arrest survival**
- **Discuss the key aspects for improved outcomes in the cardiac arrest care**
- **Define the criteria needed for performance of high quality resuscitation**

Chance of Survival?

- So how are we really doing…?



Current Statistics

	Incidence	Bystander CPR	Survivor Rate
2012	382,800	41.0%	11.4%
2013	359,400	40.1%	9.5%

American Heart Association, Heart Disease and Stroke Statistics – 2013 Update

VF Cardiac Arrest Survival Seattle & King County, 2002-2013

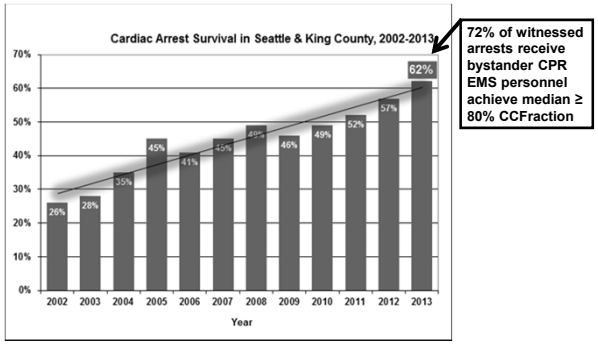


Image used with permission from Public Health - King County, Washington

http://www.kingcounty.gov/depts/health/news/2014/May/19-cardiac-survival.aspx

Lessons Learned for Optimal Resuscitation

- **Good Resuscitations starts from Good BLS Care**
  - **Improve Bystander Response**
  - **With recognition comes ACTION**
  - **Improve the Performance of High Quality CPR**

Bystander Response

Bystander Response

- **Need to recognize something is wrong**
- **Large part of action is dependent on psychosocial and behavioral elements of witnesses.**
- **This is different for every population.**
- **Want bystanders to perform CPR with a basic prompt:**

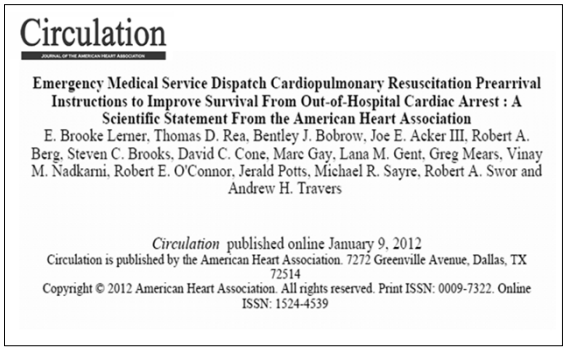
"People who suddenly collapse…"

Bystander Response

CPR Type	OR Survival
No bystander CPR	Reference
Dispatcher-assisted bystander CPR	1.45 (95% CI, 1.21, 1.73)
Bystander CPR without dispatcher assistance.	1.69 (95% CI, 1.42, 2.01)

Rea Circulation. 2001; 104: 2513-2516

Dispatch Assisted CPR



Circulation

Emergency Medical Service Dispatch Cardiopulmonary Resuscitation Prearrival Instructions to Improve Survival From Out-of-Hospital Cardiac Arrest : A Scientific Statement From the American Heart Association

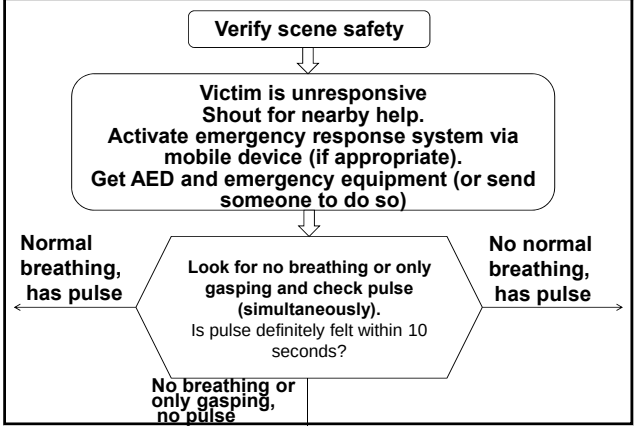
E. Brooke Lerner, Thomas D. Rea, Bentley J. Bobrow, Joe E. Acker III, Robert A. Berg, Steven C. Brooks, David C. Cone, Marc Gay, Lana M. Gent, Greg Mears, Vinay M. Nadkarni, Robert E. O'Connor, Jerald Potts, Michael R. Sayre, Robert A. Swor and Andrew H. Travers

Circulation published online January 9, 2012

Circulation is published by the American Heart Association. 7272 Greenville Avenue, Dallas, TX 72514

 Print ISSN: 0009-7322. Online ISSN: 1524-4539

2015 BLS Algorithm



Recognition of Abnormal Breathing

	Gasping	Survival % (n)	OR (95% CI)
All cardiac arrest (n=1218)	No (1027)	7.8% (80)	1.00
	Yes (191)	28.3% (54)	**3.4 (2.2–5.2)†**

Bobrow et. al. Circulation. 2008;118:2550-2554

Gasping and BCPR

Bystander CPR?	Gasping	Survival % (n)	OR (95% CI)
Yes (481)	No (404)	9.4% (38)	1.00
	Yes (77)	39.0% (30)	**5.1 (2.7–9.4)†**
No (737)	No (623)	6.7% (42)	1.00
	Yes (114)	21.1% (24)	**2.4 (1.2–4.3)***

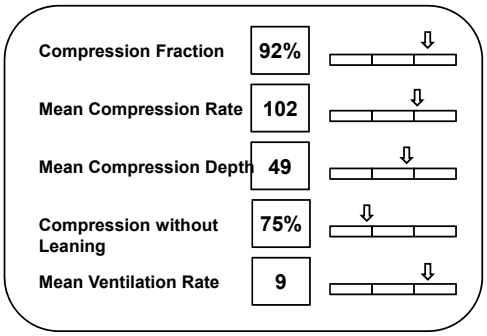
Bobrow et. al. Circulation. 2008;118:2550-2554

High Quality CPR

Improving CPR Performance

- Teach Good Basic Life Support:
- Focusing on High Quality Aspects:
  - Chest compression Rate
  - Chest compression Depth
  - Compression Fraction
- Train to the goals:
  - Rate: 100- 120 bpm
  - Depth: 2.0 - 2.4 inches

CPR Quality



Chest Compression Rate

Recommendation:

- Compression rate: 100-120/minute

Why?

- Often actual rate of compressions provided are below 100 bpm.
- Data demonstrates that compressions below 100, and above 120, adversely effect outcomes

Resuscitation Science

Relationship Between Chest Compression Rates and Outcomes From Cardiac Arrest

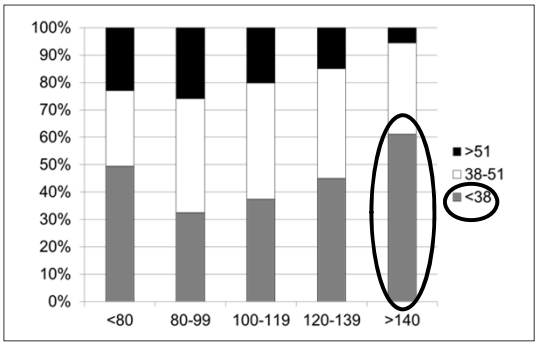
Ahamed H. Idris, MD; Danielle Guffey, BS; Tom P. Aufderheide, MD; Siobhan Brown, PhD; Laurie J. Morrison, MD, MSc; Patrick Nichols, DO; Judy Powell, BSN; Mohamud Daya, MD; Blair L. Bigham, MSc; Dianne L. Atkins, MD; Robert Berg, MD; Dan Davis, MD; Ian Stiell, MD, MSc; George Sopko, MD, MPH; Graham Nichol, MD, MPH; the Resuscitation Outcomes Consortium (ROC) Investigators

Circulation 2012; 125: 3004-3012

Conclusion:

- 3098 patients with OHCA
- Examined association of chest compression rate with outcomes of ROSC and survival
- ROSC rates peaked at compression rates ~125 bpm and then declined.

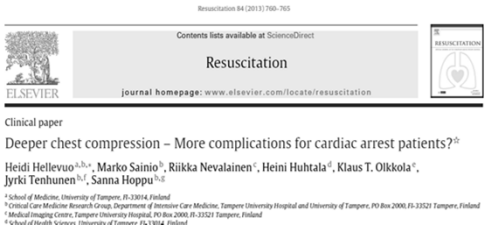
Compression Rate and Depth Relationship



Reproduced from: Idris et al, *Critical Care Medicine*, 2015:43 (4): 840

What about depth?

- Push Hard and Fast (> 2.0 inches, 5 cm)
- Has transitioned in this Guideline to 2.0 to 2.4 inches (5-6 cm)
- Why?
  - Depth is important for optimal survival
  - Increased danger with Compressions > 2.4 ?


Resuscitation 84 (2013) 760–765

Contents lists available at ScienceDirect

Resuscitation

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

Clinical paper

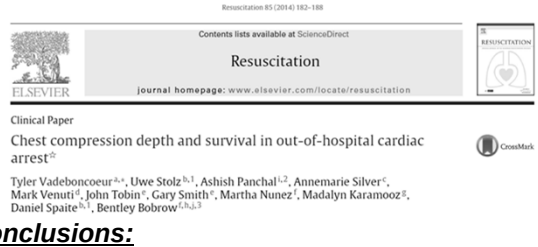
Deeper chest compression – More complications for cardiac arrest patients?☆

Heidi Hellevuo[a,b,*], Marko Sainio[b], Riikka Nevalainen[c], Heini Huhtala[d], Klaus T. Olkkola[e], Jyrki Tenhunen[b,f], Sanna Hoppu[b,g]

[a] School of Medicine, University of Tampere, FI-33014, Finland
[b] Critical Care Medicine Research Group, Department of Intensive Care Medicine, Tampere University Hospital and University of Tampere, PO Box 2000, FI-33521 Tampere, Finland
[c] Medical Imaging Centre, Tampere University Hospital, PO Box 2000, FI-33521 Tampere, Finland
[d] School of Health Sciences, University of Tampere, FI-33014, Finland

Conclusion:

- A number of iatrogenic injuries in male patients was associated with compressions during CPR increased as depth was > 6 cm.
- These were not fatal.


Resuscitation 85 (2014) 182–188

Contents lists available at ScienceDirect

Resuscitation

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

Clinical Paper

Chest compression depth and survival in out-of-hospital cardiac arrest☆

Tyler Vadeboncoeur[a,*], Uwe Stolz[b,1], Ashish Panchal[i,2], Annemarie Silver[c], Mark Venuti[d], John Tobin[e], Gary Smith[e], Martha Nunez[f], Madalyn Karamooz[g], Daniel Spaite[b,1], Bentley Bobrow[f,h,i,3]

Conclusions:

- "Deeper compressions were associated with increased survival and functional outcomes following OHCA…
- Each 5 mm increase in mean compression depth increased the odds of survival with favorable functional outcome…"(aOR: 1.29)

High Quality CPR is Critical

Without effective chest compressions:

- **Oxygen flow to brain stops**
- **Oxygen flow to heart stops**
- **Drugs go nowhere**

Training lay persons to do CPR

Mouth-to-mouth resuscitation?

Update on Sudden Cardiac Death and Resuscitation

Ruchika Husa, MD
Assistant Professor – Clinical
Department of Cardiovascular Medicine
The Ohio State University Wexner Medical Center

ROSC in Comatose Survivors

- Induced Hypothermia
- Early Invasive Strategy
- Best ICU care

Why should we cool?

- Reperfusion injury
  - Necrosis/apoptosis
  - Inflammation
  - Reactive oxygen species
- Improved defibrillation
- Neurologic recovery

Why should we cool?

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*

N Engl J Med 2002; 346:549-556
http://www.nejm.org/doi/full/10.1056/NEJMoa012689

INDUCED HYPOTHERMIA AFTER OUT-OF-HOSPITAL CARDIAC ARREST

TREATMENT OF COMATOSE SURVIVORS OF OUT-OF-HOSPITAL CARDIAC ARREST WITH INDUCED HYPOTHERMIA

STEPHEN A. BERNARD, M.B., B.S., TIMOTHY W. GRAY, M.B., B.S., MICHAEL D. BUIST, M.B., B.S., BRUCE M. JONES, M.B., B.S., WILLIAM SILVESTER, M.B., B.S., GEOFF GUTTERIDGE, M.B., B.S., AND KAREN SMITH, B.SC.

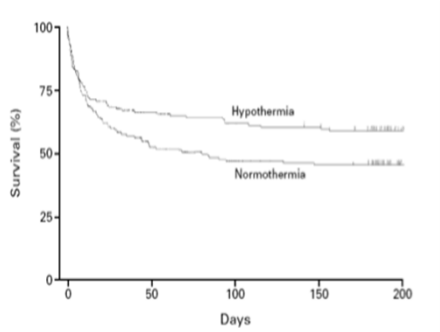
N Engl J Med 2002; 346:557-563
http://www.nejm.org/doi/full/10.1056/NEJMoa003289

- Entry criteria: witnessed cardiac arrest with first resuscitation attempt 5-15 min after collapse, ROSC (<60 from collapse), persistent coma, VF.
- Exclusion criteria: severe cardiogenic shock, hypotension (SBP <90mmHg), persistent arrhythmias, primary coagulopathy.
- Approximately 92% of screened participants were excluded.

PROTOCOL

- **In European study, patients were cooled using a special mattress and ice packs. Target temp 32℃ to 34℃ for 24 hours. Rewarming over 8 hours.**
- **Australian study used cold packs in the field. Target temp 33℃ for 12 hours. Rewarming over 6 hours.**

Why should we cool?



Hypothermia After Cardiac Arrest Study Group (2002) *NEJM*

NEUROLOGIC OUTCOME AND MORTALITY AT SIX MONTHS

OUTCOME	NORMOTHERMIA no./total no. (%)	HYPOTHERMIA	RISK RATIO (95% CI)*	P VALUE†
Favorable neurologic outcome	54/137 (39)	75/136 (55)	1.40 (1.08–1.81)	0.009
Death	65/138 (55)	56/137 (41)	0.74 (0.58–0.95)	0.02

ALS Task Force recommendation in 2002

- **Unconscious adult patients with spontaneous circulation after out-of-hospital cardiac arrest should be cooled to 32℃ to 34℃ for 12-24 hours when initial rhythm was ventricular fibrillation.**
- **Such cooling may be beneficial for other rhythms or in-hospital cardiac arrest.**

Recent trial

The NEW ENGLAND JOURNAL of MEDICINE

ORIGINAL ARTICLE

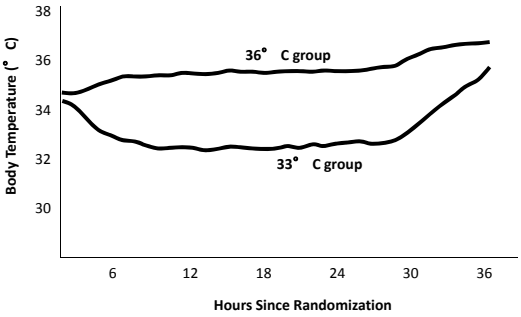
Targeted Temperature Management at 33°C versus 36°C after Cardiac Arrest

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.,

Trial design

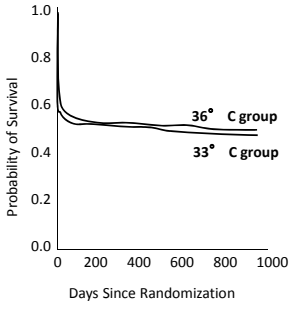
- **Randomized 950 unconscious adults after out-of-hospital cardiac arrest of presumed cardiac cause (irrespective of initial rhythm) to targeted temperature management at either 33° C or 36° C.**
- **The primary outcome was all-cause mortality through the end of the trial.**
- **Secondary outcomes included a composite of poor neurologic function or death at 180 days**

Body Temperature During The Intervention Period



Nielsen N et al. N Engl J Med 2013;369:2197-2206.

Probably Of Survival Through The End Of The Trial



Number At Risk

33° C group	473	230	151	64	15
36° C group	466	235	144	68	12

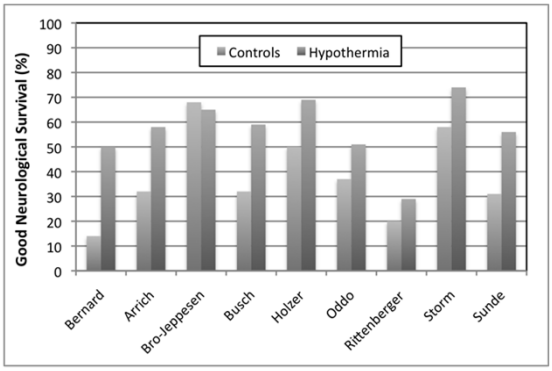
Nielsen N et al. N Engl J Med 2013;369:2197-2206.

Results

Table 2. **Outcomes.**

Outcome	33°C Group	36°C Group	Hazard Ratio or Risk Ratio (95% CI)*	P Value
	no./total no. (%)			
Primary outcome: deaths at end of trial	235/473 (50)	225/466 (48)	1.06 (0.89–1.28)	0.51
Secondary outcomes				
Neurologic function at follow-up†				
CPC of 3–5	251/469 (54)	242/464 (52)	1.02 (0.88–1.16)	0.78
Modified Rankin scale score of 4–6	245/469 (52)	239/464 (52)	1.01 (0.89–1.14)	0.87
Deaths at 180 days	226/473 (48)	220/466 (47)	1.01 (0.87–1.15)	0.92

Why should we cool?



When? Pre-hospital hypothermia

- **Kim et al, Effect of pre-hospital induction of mild hypothermia on survival and neurological status among adults with cardiac arrest: a randomized clinical trial.**
- **Use of pre-hospital cooling reduced core temperature by hospital arrival and reduced the time to reach a temperature of 34° C**
- **It did not improve survival or neurological status among patients resuscitated from pre-hospital VF or those without VF.**

Timing of Induced Hypothermia

- **As soon as possible after presentation to the ER.**
- **One nonrandomized report found an associated 20% increase in mortality rate with every hour of delay in initiating cooling.**
- **It should neither delay nor interfere with an early invasive approach.**

Who should we cool?

- All arrest victims?
  - Brain doesn't know the rhythm
- Only ventricular fibrillation?
  - Evidence-based approach
- Non-VF patients?
  - Infection
  - CHF
  - Bleeding

Resuscitation - September 2011

Mild therapeutic hypothermia is associated with favourable outcome in patients after cardiac arrest with non-shockable rhythms

- Retrospective analysis of adult cardiac arrest survivors suffering a witnessed out-of-hospital cardiac arrest with asystole or pulseless electric activity as the first documented rhythm.

- Patients who were treated with mild therapeutic hypothermia were more likely to have good neurological outcomes, odds ratio of 1.84 (95% confidence interval: 1.08–3.13).

- Mortality was significantly lower in the hypothermia group (odds ratio: 0.56; 95% confidence interval: 0.34–0.93).

Resuscitation - February 2012

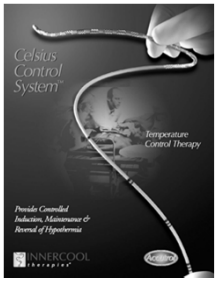
Does therapeutic hypothermia benefit adult cardiac arrest patients presenting with non-shockable initial rhythms?: A systematic review and meta-analysis of randomized and non-randomized studies.

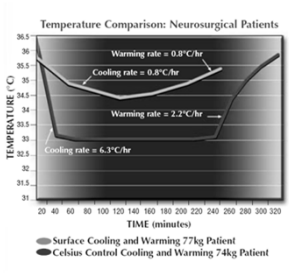
- TH is associated with reduced in-hospital mortality for adults patients resuscitated from non-shockable CA.

How should we cool?

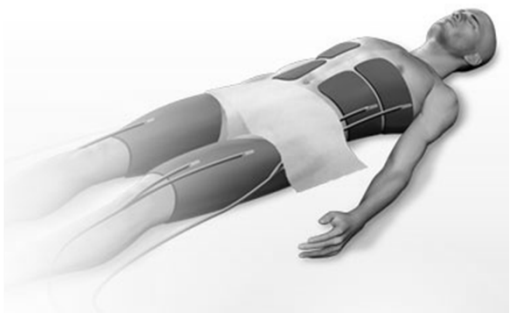
- Surface cooling
  - Evaporative
  - Ice packs/chemical
  - Cooling pads
- Internal strategies
  - Cooled intravenous fluids
  - Intravascular catheters
  - Intranasal catheters

Cooling Catheters





Surface Cooling



Complications of Hypothermia

- Coagulopathy
  - Overshoot?
- Hemodynamic
- Dysrhythmias
- Infectious
  - Sepsis, pneumonia
- Electrolyte disturbances

Complications

TABLE 4. COMPLICATIONS DURING THE FIRST SEVEN DAYS AFTER CARDIAC ARREST.*

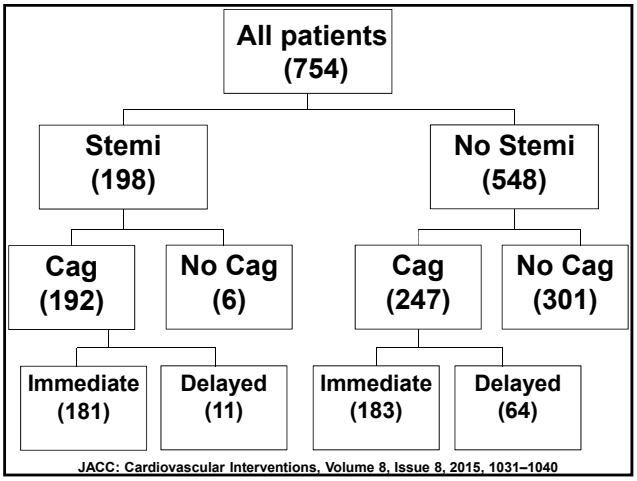
COMPLICATION	NORMOTHERMIA	HYPOTHERMIA
	no./total no. (%)	
Bleeding of any severity†	26/138 (19)	35/135 (26)
Need for platelet transfusion	0/138	3/135 (2)
Pneumonia	40/137 (29)	50/135 (37)
Sepsis	9/138 (7)	17/135 (13)
Pancreatitis	2/138 (1)	1/135 (1)
Renal failure	14/138 (10)	13/135 (10)
Hemodialysis	6/138 (4)	6/135 (4)
Pulmonary edema	5/133 (4)	9/136 (7)
Seizures	11/133 (8)	10/136 (7)
Lethal or long-lasting arrhythmia	44/138 (32)	49/135 (36)
Pressure sores	0/133	0/136

Summary for TTM: 2015 update

- All comatose adult patients with ROSC after cardiac arrest should undergo TTM.
- Mild hypothermia equally good. Temperature range 32-36 degrees Celsius.
- Routine pre-hospital hypothermia is not recommended.
- Although some methods of cooling are more convenient, none have been shown superior to the others for patient outcomes.

Coronary Angiography

- Background The 2013 STEMI guidelines recommend performing immediate angiography in resuscitated patients whose initial electrocardiogram shows STEMI. The optimal approach for those without STEMI post–cardiac arrest is less clear.
- Kern et al A retrospective evaluation of a post–cardiac arrest registry was performed.
- Objectives The aim of this study was to compare outcomes and coronary angiographic findings in post–cardiac arrest patients with and without ST-segment elevation myocardial infarction (STEMI).



JACC: Cardiovascular Interventions, Volume 8, Issue 8, 2015, 1031–1040

Coronary Angiography

- The database consisted of 746 comatose post–cardiac arrest patients including 198 with STEMI (26.5%) and 548 without STEMI (73.5%).
- A culprit vessel was more frequently identified in those with STEMI, but also in one-third of patients without STEMI (80.2% vs. 33.2%; p = 0.001).
- The majority of culprit vessels were occluded (STEMI, 92.7%; no STEMI, 69.2%; p < 0.0001).
- An occluded culprit vessel was found in 74.3% of STEMI patients and in 22.9% of no STEMI patients.

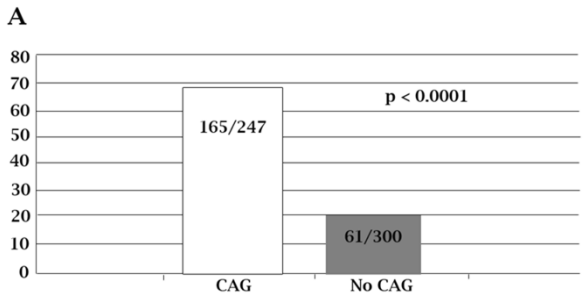
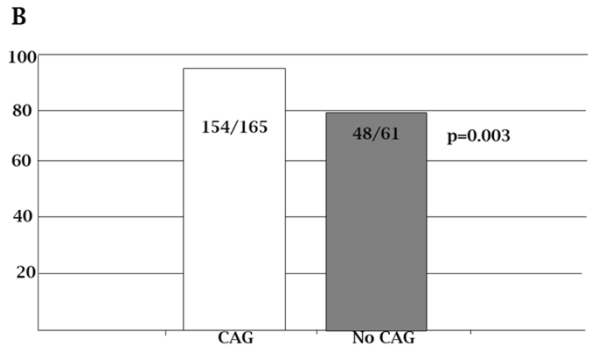


Figure 2. Survival to Discharge and Favorable Neurological Outcome in Those Without ST Elevation Coronary angiography is associated with improved survival to hospital discharge among patients without ST-segment elevation myocardial infarction (A) and with good neurologic outcomes.

JACC: Cardiovascular Interventions, Volume 8, Issue 8, 2015, 1031–1040



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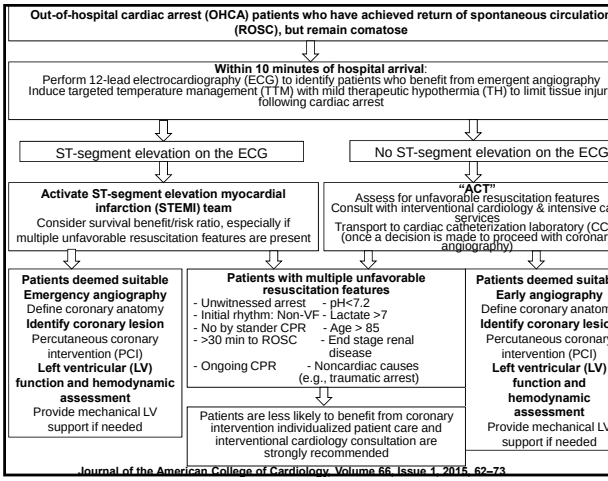
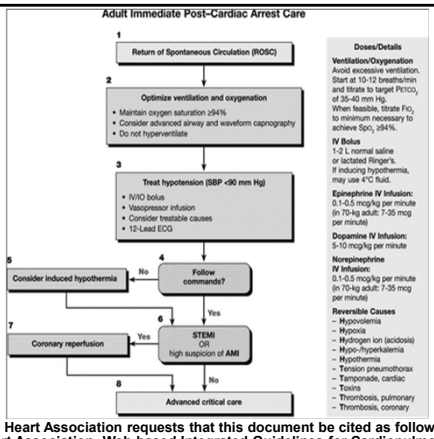


Journal of the American College of Cardiology, Volume 65, Issue 1, 2015, 62–73

Coronary Angiography in Comatose patients with ROSC

- **Conclusions Early coronary angiography is associated with improved functional outcome among resuscitated patients with and without STEMI. Resuscitated patients with a presumed cardiac etiology appear to benefit from immediate coronary angiography.**
- **PEARL Study.**



Post-Arrest Care

Resuscitation (2007) 74, 44–51

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RESUSCITATION

www.elsevier.com/locate/resuscitation

CLINICAL PAPER

The feasibility of a regional cardiac arrest receiving system☆

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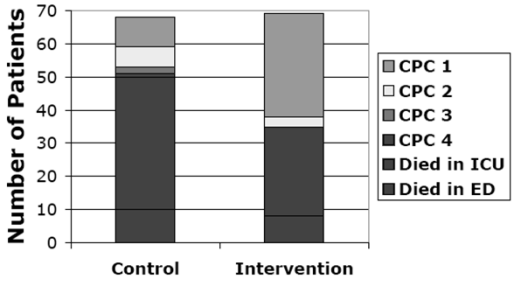
Post-Arrest Care

- Cooling
- Emergency PCI
- Good ICU care
- Rehabilitation

Post-Arrest Care



Sunde (2007) *Resuscitation*