Highlights from the 2015 Guidelines update

Center for Resuscitation Science
Penn Emergency Medicine

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Speaker disclosures

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	PCORI
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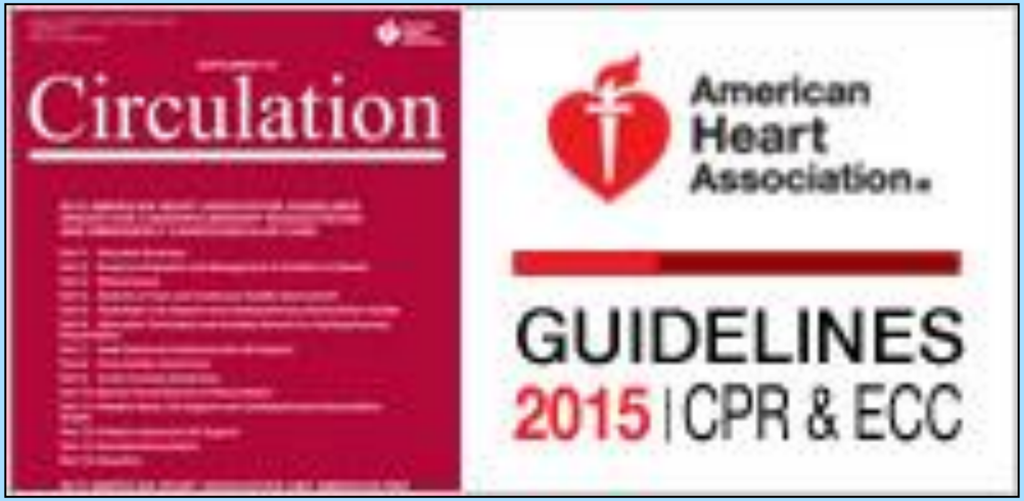
The AHA guidelines: an overview

Resuscitation guidelines are updated every 5 years

Collaboration of physicians, nurses and EMTs

Science recommendations from ILCOR

US guidelines (AHA) based on ILCOR science recs



Chest compression rate

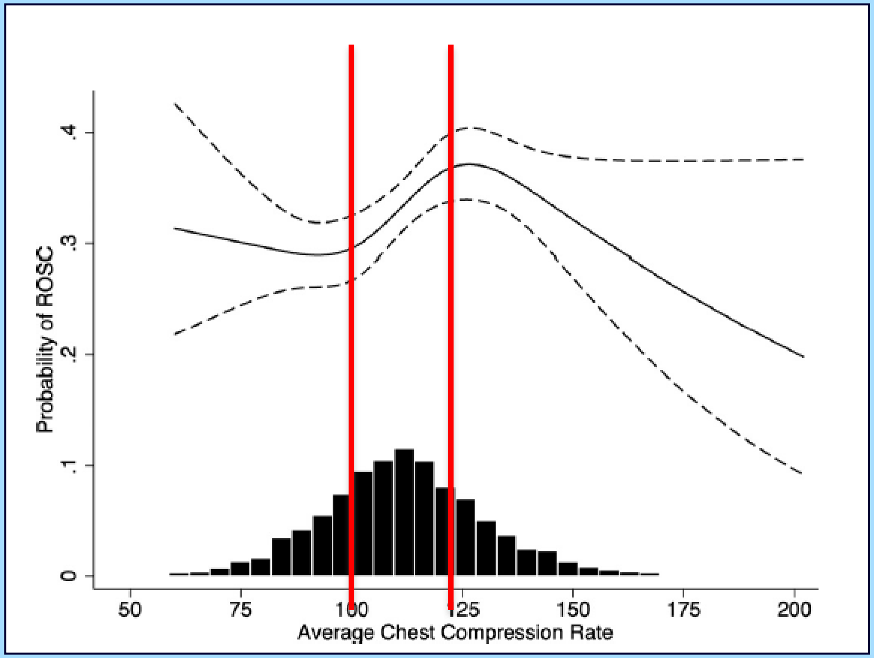
Chest Compression Rate*

2015 (Updated): In adult victims of cardiac arrest, it is reasonable for rescuers to perform chest compressions at a rate of 100 to 120/min.

2010 (Old): It is reasonable for lay rescuers and HCPs to perform chest compressions at a rate of at least 100/min.

New upper limit to chest compression rate

Based on large OHCA studies showing worse outcomes



Chest compression depth

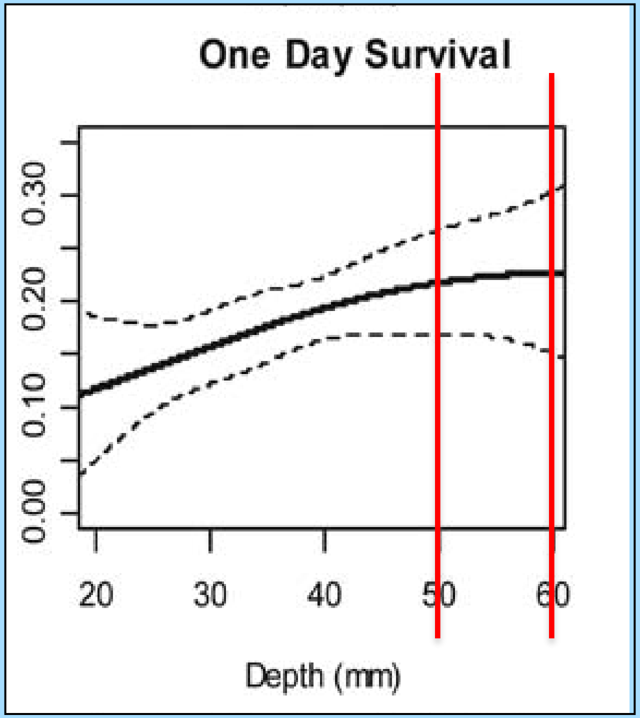
Chest Compression Depth*

2015 (Updated): During manual CPR, rescuers should perform chest compressions to a depth of at least 2 inches (5 cm) for an average adult, while avoiding excessive chest compression depths (greater than 2.4 inches [6 cm]).

2010 (Old): The adult sternum should be depressed at least 2 inches (5 cm).

New upper limit to chest compression depth

Upper limit based on weak evidence; may be more academic than real-world



Mechanical CPR devices

Mechanical Chest Compression Devices

2015 (Updated): The evidence does not demonstrate a benefit with the use of mechanical piston devices for chest compressions versus manual chest compressions in patients with cardiac arrest. Manual chest compressions remain the standard of care for the treatment of cardiac arrest. However, such a device may be a reasonable alternative to conventional CPR in specific settings where the delivery of high-quality manual compressions may be challenging or dangerous for the provider (eg, limited rescuers available, prolonged CPR, CPR during hypothermic cardiac arrest, CPR in a moving ambulance, CPR in the angiography suite, CPR during preparation for ECPR).

2010 (Old): Mechanical piston devices may be considered for use by properly trained personnel in specific settings for the treatment of adult cardiac arrest in circumstances (eg,

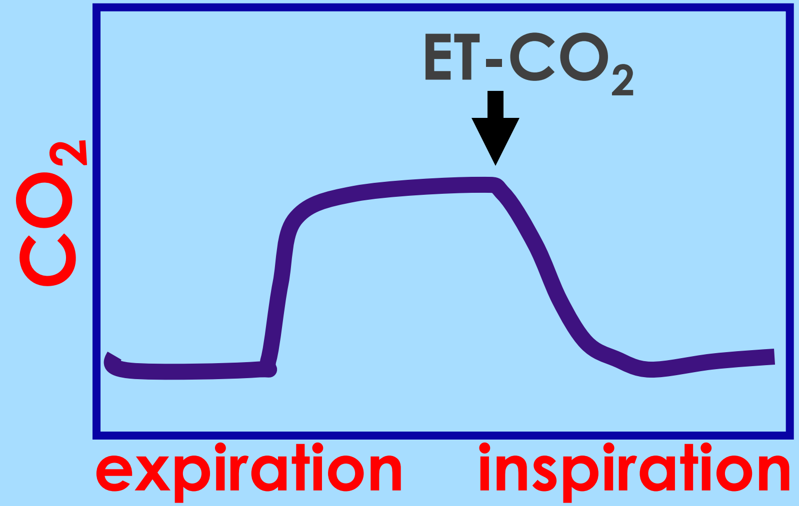
Mechanical CPR and manual CPR are equivalent – no advantage to mechanical CPR

End-tidal carbon dioxide (ET-CO_2)

$ETCO_2$ for Prediction of Failed Resuscitation

2015 (New): In intubated patients, failure to achieve an $ETCO_2$ of greater than 10 mm Hg by waveform capnography after 20 minutes of CPR may be considered as one component of a multimodal approach to decide when to end resuscitative efforts but should not be used in isolation.

Why: Failure to achieve an $ETCO_2$ of 10 mm Hg by waveform capnography after 20 minutes of resuscitation has been associated with an extremely poor chance of ROSC and survival. However, the studies to date are limited in that they have potential confounders and have included relatively small numbers of patients, so it is inadvisable to rely solely on $ETCO_2$ in determining when to terminate resuscitation.



A role for end-tidal CO_2 in prognostication – less clear of a role to assess CPR effectiveness

TTM: target temperature

Targeted Temperature Management

2015 (Updated): All comatose (ie, lacking meaningful response to verbal commands) adult patients with ROSC after cardiac arrest should have TTM, with a target temperature between 32°C and 36°C selected and achieved, then maintained constantly for at least 24 hours.

2010 (Old): Comatose (ie, lacking of meaningful response to verbal commands) adult patients with ROSC after out-of-hospital VF cardiac arrest should be cooled to 32°C to 34°C for 12 to 24 hours. Induced hypothermia also may be considered for comatose adult patients with ROSC after IHCA of any initial rhythm or after OHCA with an initial rhythm of pulseless electrical activity or asystole.

Acceptable range of TTM target temp now expanded: 32^{o}C-36^{o}C

Goal should be specific within this range – selection tailored to patient

Newer trials evaluating TTM target

The NEW ENGLAND JOURNAL of MEDICINE

2013

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.,

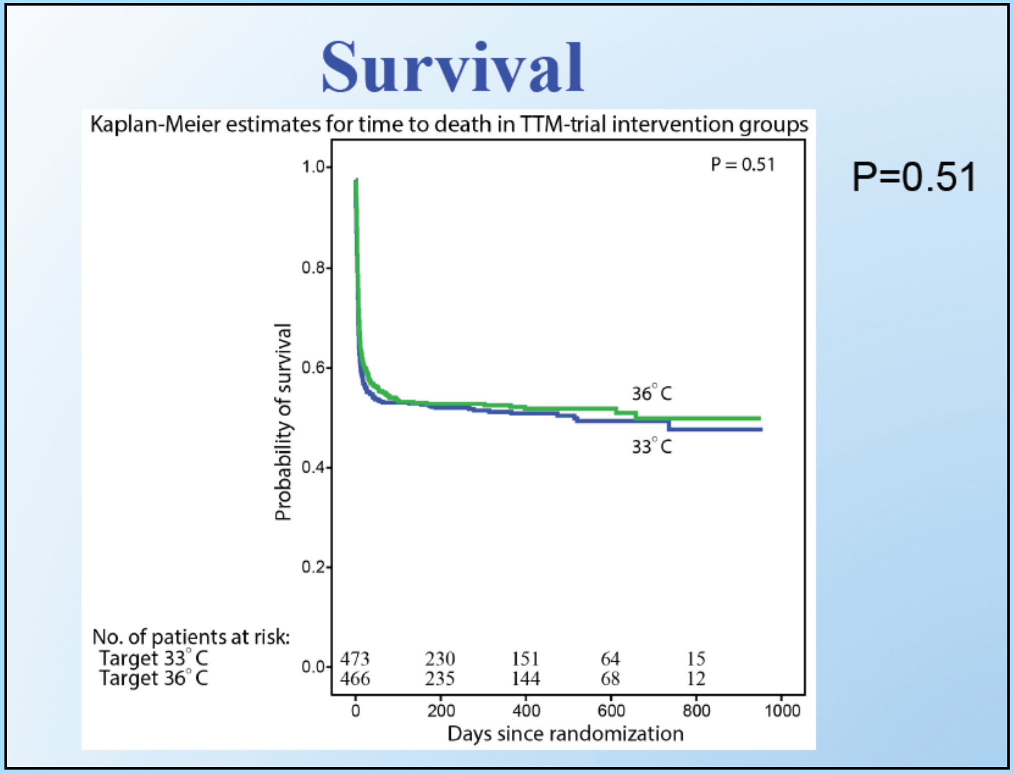
2015

ORIGINAL ARTICLE

Therapeutic Hypothermia after Out-of-Hospital Cardiac Arrest in Children

Frank W. Moler, M.D., Faye S. Silverstein, M.D., Richard Holubkov, Ph.D.,

Survival in the Nielsen et al trial



No difference in outcomes at either 33°C or 36°C

No differences in adverse effects between groups

Pre-hospital TTM via cold fluids

2015 Recommendation—New

We recommend **against** the routine prehospital cooling of patients after ROSC with rapid infusion of cold intravenous fluids (Class III: No Benefit, LOE A).

Cold fluids in the pre-hospital setting are not recommended – no RCT has shown benefit

Original Investigation

Effect of Prehospital Induction of Mild Hypothermia on Survival and Neurological Status Among Adults With Cardiac Arrest
A Randomized Clinical Trial

Francis Kim, MD; Graham Nichol, MD, MPH; Charles Maynard, PhD; Al Hallstrom, PhD; Peter J. Kudenchuk, MD; Thomas Rea, MD, MPH; Michael K. Copass, MD; David Carlbom, MD; Steven Deem, MD; W. T. Longstreth Jr, MD; Michele Olsufka, RN; Leonard A. Cobb, MD

Hope for prehospital TTM?

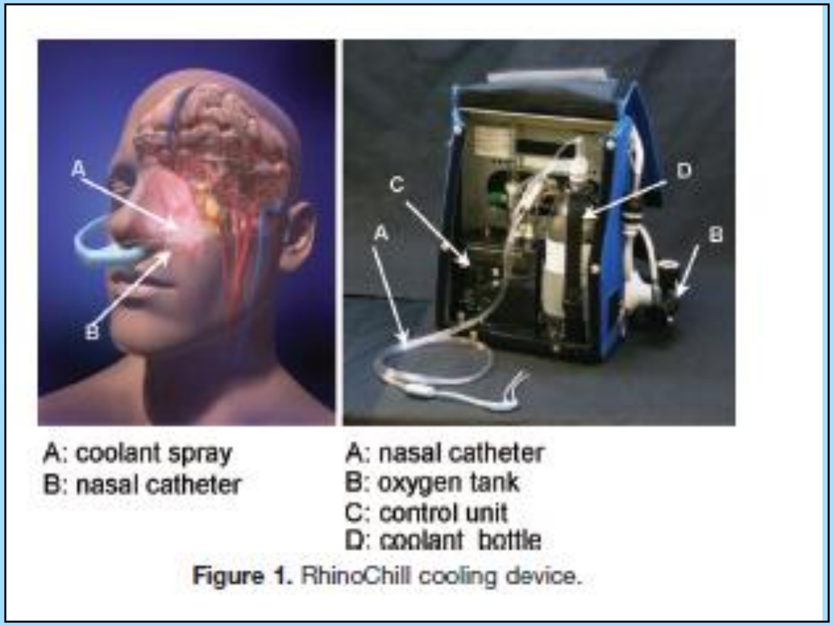


Figure 1. RhinoChill cooling device.

Newer technologies may change perspective

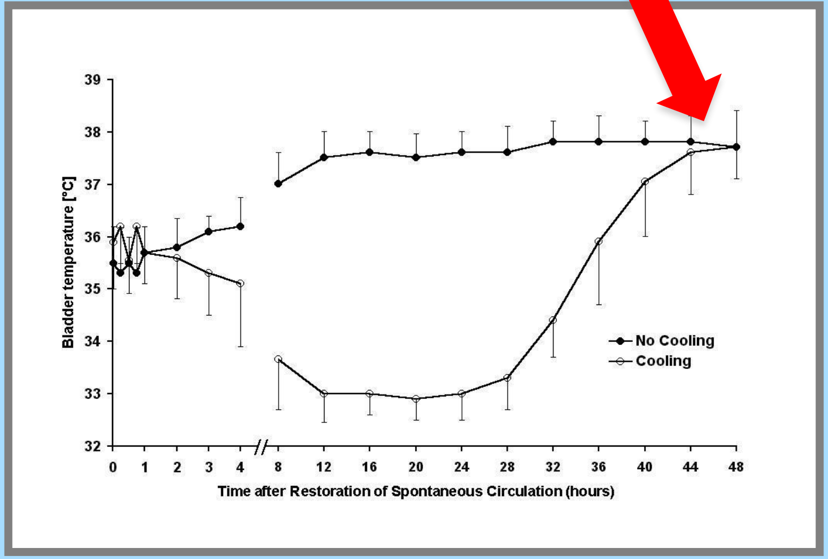
Intra-arrest TTM as a possible approach?

TTM: post-rewarming management

Continuing Temperature Management Beyond 24 Hours

2015 (New): Actively preventing fever in comatose patients after TTM is reasonable.

Why: In some observational studies, fever after rewarming from TTM is associated with worsened neurologic injury, although studies are conflicting. Because preventing fever after TTM is relatively benign and fever may be associated with harm, preventing fever is suggested.



Fever after rewarming may require aggressive prevention to minimize neurologic injuries

Post-TTM normothermia: the science

Prevalence and effect of fever on outcome following resuscitation from cardiac arrest☆

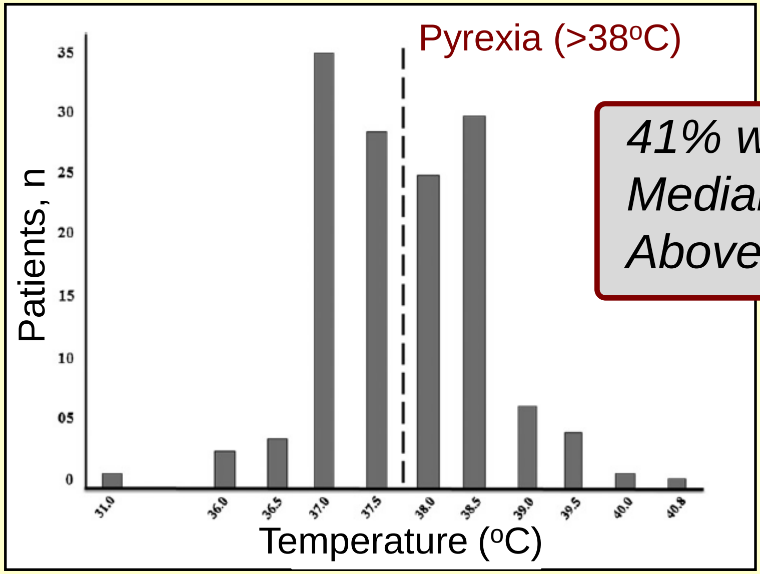
Kory Gebhardt[a], Francis X. Guyette[b], Ankur A. Doshi[b], Clifton W. Callaway[b], Jon C. Rittenberger[b,*], The Post Cardiac Arrest Service[bc]

2013

Pyrexia and neurologic outcomes after therapeutic hypothermia for cardiac arrest☆

Marion Leary[a,b,1], Anne V. Grossestreuer[a,1], Stephen Iannacone[a,1], Mariana Gonzalez[a,1], Frances S. Shofer[a,1], Clare Povey[c,1], Gary Wendell[c,1], Susan E. Archer[d,1], David F. Gaieski[a,1], Benjamin S. Abella[a,b,*,1]

2013



41% with post-TTM pyrexia
Median temp 38.7°C
Above median: worse outcomes

Both studies: fever may contribute to poor outcomes

Biology of prolonged temp control

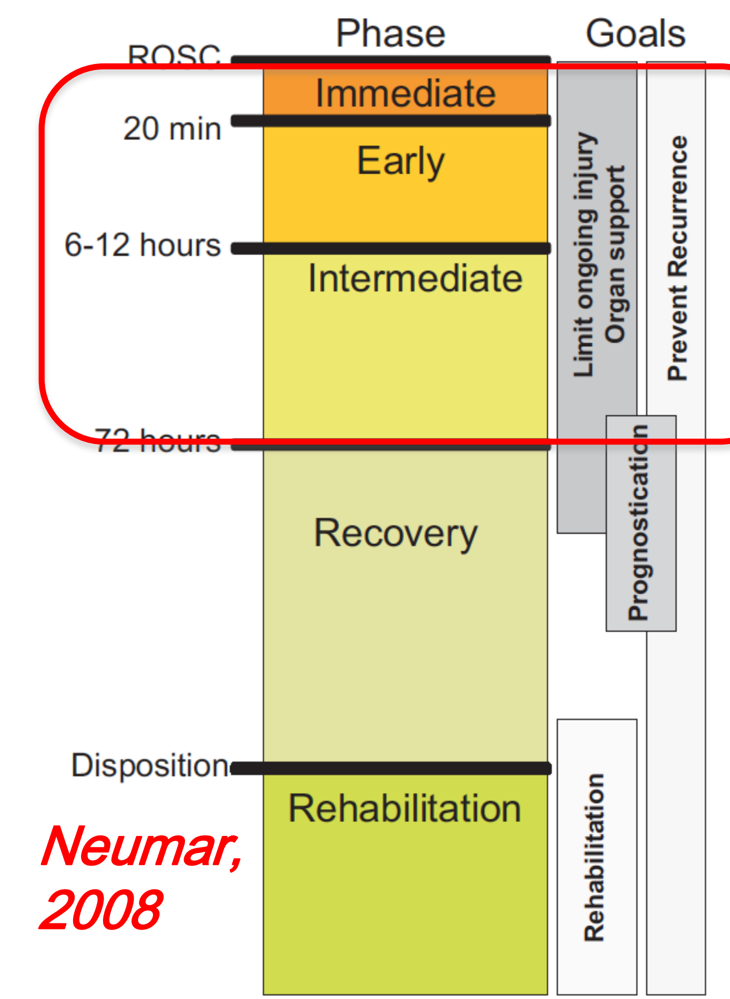


Figure. Phases of post–cardiac arrest syndrome.

Ongoing injury up to 72 hours supported by laboratory and clinical studies

Our TTM protocol specifies 24 hour period of "controlled normothermia" post-rewarming

Longer period of TTM?

Longer period of post-TTM normothermia?

Post-arrest hemodynamic goals

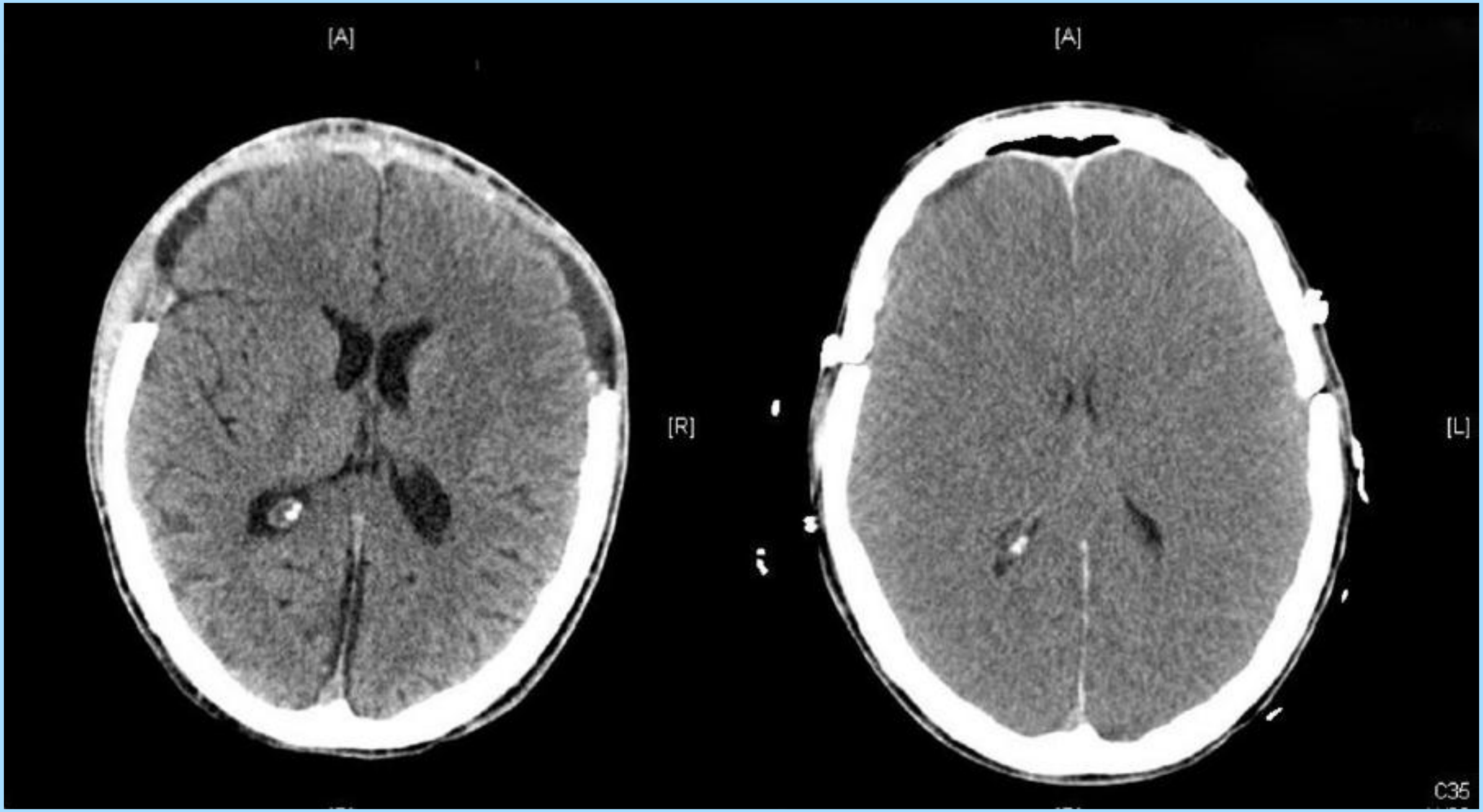
Hemodynamic Goals After Resuscitation

2015 (New): It may be reasonable to avoid and immediately correct hypotension (systolic blood pressure less than 90 mm Hg, mean arterial pressure less than 65 mm Hg) during post–cardiac arrest care.

Avoiding hypotension during post-arrest critical care is important

Analogous to CVA hemodynamics

Post-arrest brain swelling



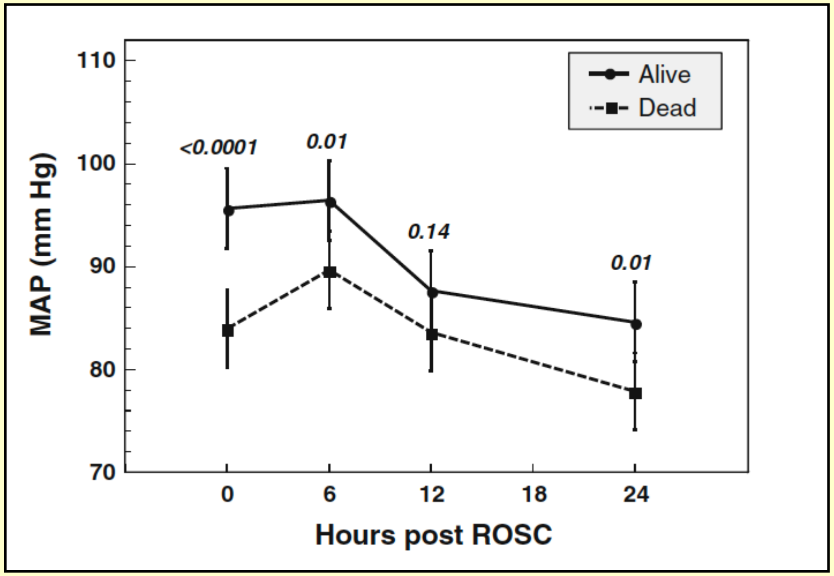
Elevated ICP in days following Resuscitation from arrest

Hemodynamic management

Marie E. Beylin
Sarah M. Perman
Benjamin S. Abella
Marion Leary
Frances S. Shofer
Anne V. Grossestreuer
David F. Gaieski

Higher mean arterial pressure with or without vasoactive agents is associated with increased survival and better neurological outcomes in comatose survivors of cardiac arrest

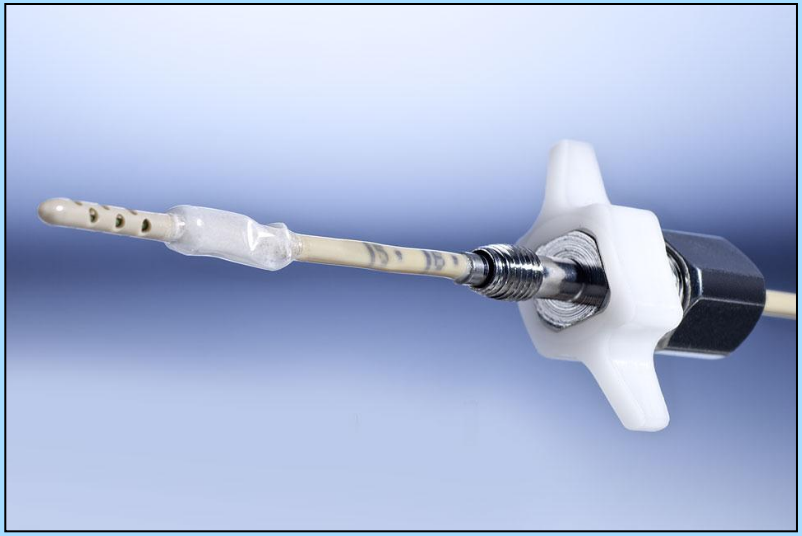
2013



Higher mean arterial pressure associated with improved outcome

Goal MAP unclear
>65 mm Hg per AHA guidelines
but this study suggests >80 mm Hg

Problem with MAP target post-arrest



We don’t measure ICP routinely following resuscitation from arrest

Hard to titrate blood pressure to ICP if the ICP isn’t measured

Post-arrest neuroprognostication

Prognostication After Cardiac Arrest

2015 (New): The earliest time to prognosticate a poor neurologic outcome using clinical examination in patients *not* treated with TTM is 72 hours after cardiac arrest, but this time can be even longer after cardiac arrest if the residual effect of sedation or paralysis is suspected to confound the clinical examination.

Clinical exam is unreliable for at least 72 hours following resuscitation

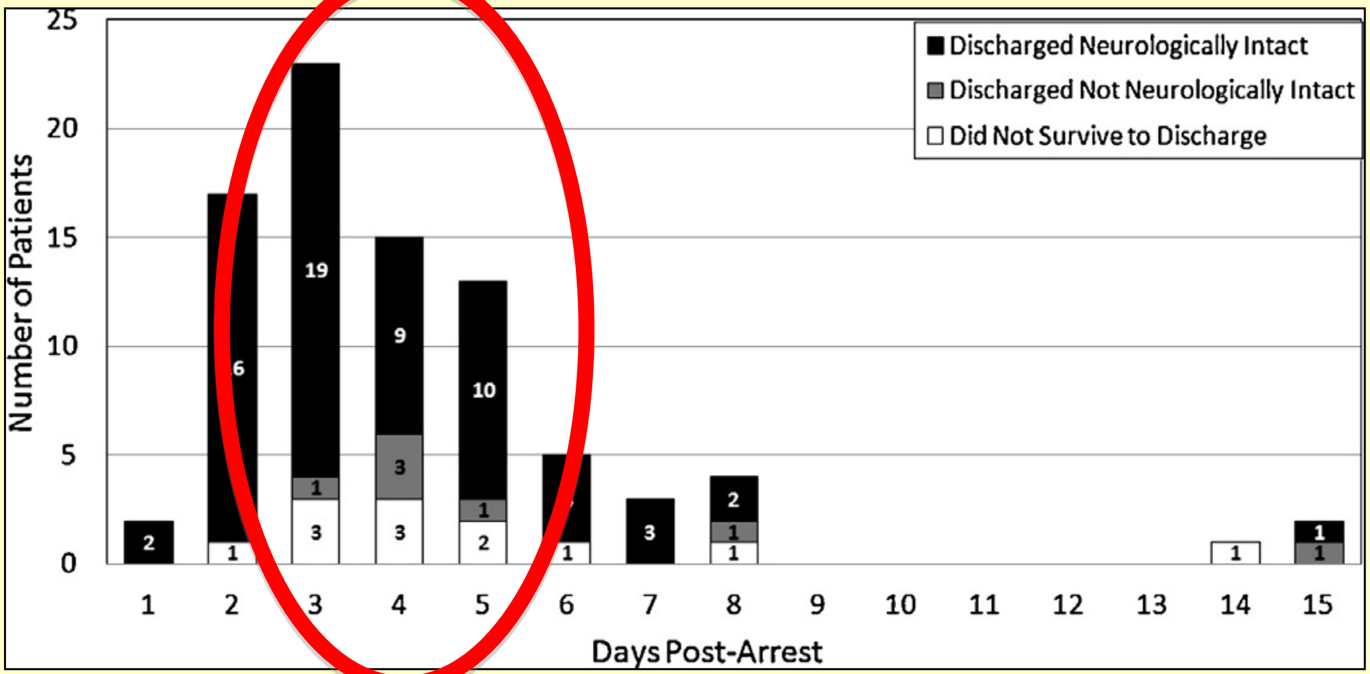
Cannot withdraw based on bedside exam

Timing of prognostication

Time to awakening and neurologic outcome in therapeutic hypothermia-treated cardiac arrest patients☆,☆☆

Anne V. Grossestreuer[a], Benjamin S. Abella[a], Marion Leary[a], Sarah M. Perman[a], Barry D. Fuchs[b], Daniel M. Kolansky[c], Marie E. Beylin[d], David F. Gaieski[a,*]

2013

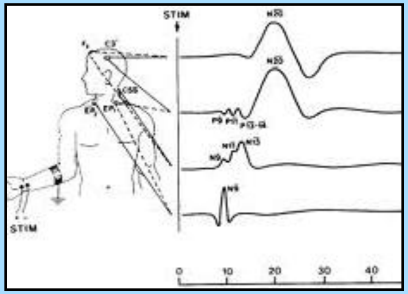


Reinforces notion that withdrawal decisions should be delayed >72 h post-rewarming; clinical neuro exam poorly predictive

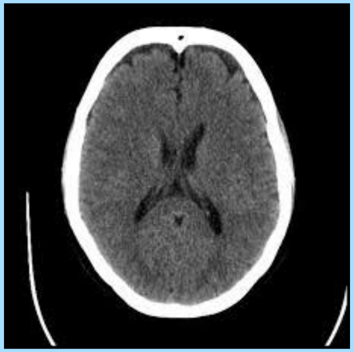
Tools to assist neuroprognostication

EEG

Bispectral index (BIS)



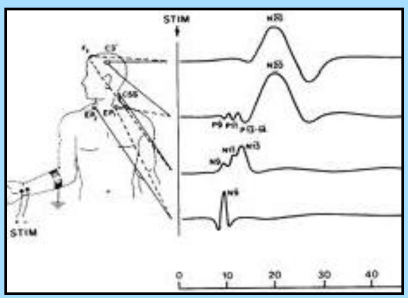
Somatosensory evoked potential (SSEP)



neuroimaging

Varying strength of data for each modality; no one approach sufficient for prognostication

SSEP is an underutilized modality



Somatosensory evoked potential (SSEP)

N20 response at 72 hours – Relatively strong predictor of outcome

BIS index as post-arrest monitor

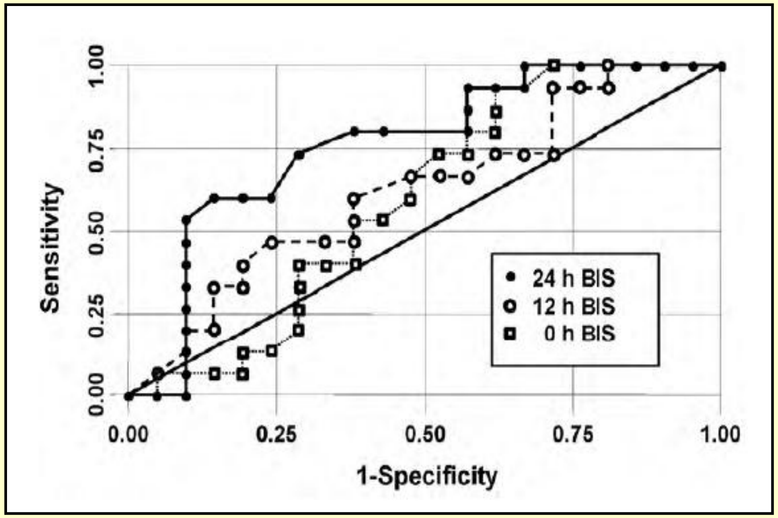
Neurologic prognostication and bispectral index monitoring after resuscitation from cardiac arrest☆

Marion Leary[a], David A. Fried[a], David F. Gaieski[a], Raina M. Merchant[a], Barry D. Fuchs[b], Daniel M. Kolansky[c], Dana P. Edelson[d], Benjamin S. Abella[a,b,*]

2010

BIS measurement is most reliable neuroprognosticator At 24 hours post-arrest

Still relatively poor predictor: 24 hr BIS cutoff of 45 to predict good outcome: sensitivity of 63%, specificity of 86% (positive likelihood ratio of 4.7) BIS = 0 strongly predicted poor outcome



Options for neurologic assessment

Box 2

Useful Clinical Findings That Are Associated With Poor Neurologic Outcome*

- Absence of pupillary reflex to light at 72 hours or more after cardiac arrest
- Presence of status myoclonus (different from isolated myoclonic jerks) during the first 72 hours after cardiac arrest
- Absence of the N20 somatosensory evoked potential cortical wave 24 to 72 hours after cardiac arrest or after rewarming
- Presence of a marked reduction of the gray-white ratio on brain CT obtained within 2 hours after cardiac arrest
- Extensive restriction of diffusion on brain MRI at 2 to 6 days after cardiac arrest
- Persistent absence of EEG reactivity to external stimuli at 72 hours after cardiac arrest
- Persistent burst suppression or intractable status epilepticus on EEG after rewarming

Absent motor movements, extensor posturing, or myoclonus should not be used alone for predicting outcome.

*Shock, temperature, metabolic derangement, prior sedatives or neuromuscular blockers, and other clinical factors should be considered carefully because they may affect results or interpretation of some tests.

Abbreviations: CT, computed tomography; EEG, electroencephalogram; MRI, magnetic resonance imaging.

AHA offers "menu" of options to help assess neurologic outcomes

Note the fine print: sedatives, paralytics, shock and other conditions can confound findings

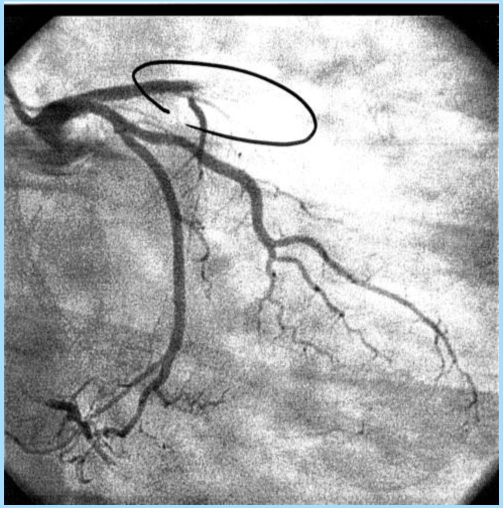
Post-arrest cardiac catheterization

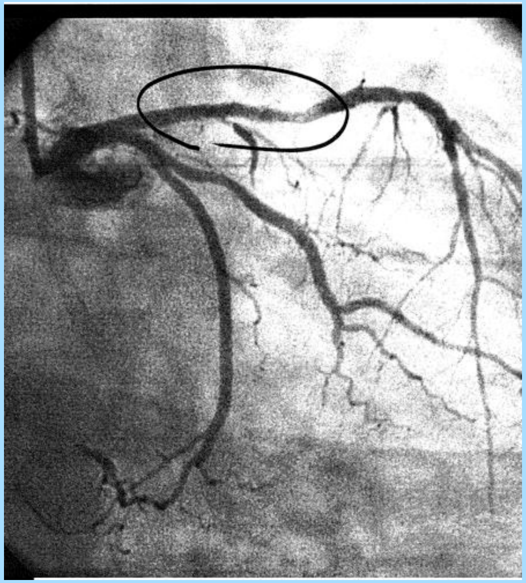
2015 Recommendations—Updated

Coronary angiography should be performed emergently (rather than later in the hospital stay or not at all) for OHCA patients with suspected cardiac etiology of arrest and ST elevation on ECG (Class I, LOE B-NR).

Emergency coronary angiography is reasonable for select (eg, electrically or hemodynamically unstable) adult patients who are comatose after OHCA of suspected cardiac origin but without ST elevation on ECG (Class IIa, LOE B-NR).

Coronary angiography is reasonable in post–cardiac arrest patients for whom coronary angiography is indicated regardless of whether the patient is comatose or awake (Class IIa, LOE C-LD).





Cardiac catheterization should be considered after resuscitation and performed for select patients

PCI <u>required</u> for STEMI post-arrest

Difficult to predict coronary disease

Initial Clinical Predictors of Significant Coronary Lesions After Resuscitation from Cardiac Arrest

2012

Mariana R. Gonzalez, B.A.,[1] Emily C. Esposito, B.A.,[1] Marion Leary, B.S.N., R.N.,[1] David F. Gaieski, M.D.,[1] Daniel M. Kolansky, M.D.,[2] Gene Chang, M.D.,[2] Lance B. Becker, M.D.,[1] Brendan G. Carr, M.D., MSCE,[1] Anne V. Grossestreuer, M.S.,[1] and Benjamin S. Abella, M.D., M.Phil[1,3]

Characteristics	*Univariate analysis OR (95% CI)*	p-*Value*	*Adjusted analysis OR (95% CI)*	p-*Value*
Age >50 years	1.78 (0.7–4.4)	0.210	0.8 (0.3–2.3)	0.647
Past medical history				
Coronary disease	7.2 (2.0–25.9)	0.002	6.2 (1.6–24.4)	0.009
Hypertension	1.4 (0.6–3.0)	0.45	0.8 (0.3–2.0)	0.41
Tobacco use	2.1 (0.9–4.6)	0.079	2.4 (0.9–6.3)	0.068
Initial rhythm (VF/VT)	3.0 (1.2–7.3)	0.018	2.9 (1.1–7.7)	0.033
Abnormal initial troponin	1.1 (0.5–2.5)	0.82	1.0 (0.4–2.5)	0.97
ST/T wave abnormalities on initial postarrest ECG	1.25 (0.5–2.8)	0.58	1.2 (0.5–3.1)	0.64

Only prior coronary history and initial rhythm were associated with significant coronary lesions on post-arrest catheterization

Age, troponin, ECG findings were NOT associated with coronary dz

Benefit of prompt post-arrest PCI

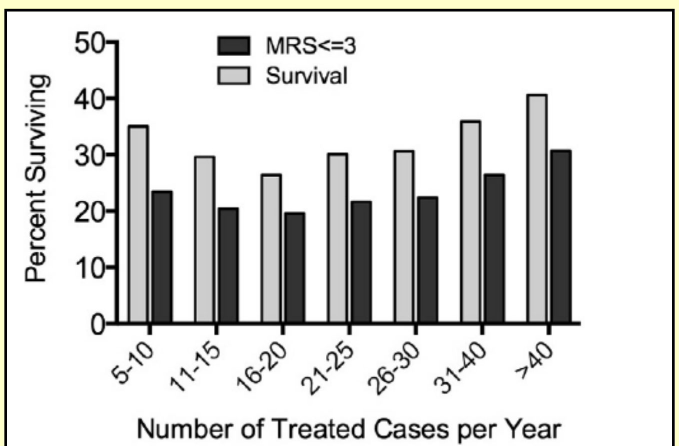
Early coronary angiography and induced hypothermia are associated with survival and functional recovery after out-of-hospital cardiac arrest☆

2014

Clifton W. Callaway[a,*], Robert H. Schmicker[b], Siobhan P. Brown[b], J. Michael Albrich[c],

	Survival to hospital discharge (*N* = 1368)		
	N	Odds ratio	Adjusted odds ratio[a]
Early coronary angiography (*N* = 765)	495 (64.7%)	4.08 (3.65, 4.56)	1.69 [1.06,2.70]
Reperfusion subjects (PCI or fibrinolytics) (*N* = 705)	377 (62.4%)	5.30 (4.74, 5.93)	1.94 [1.34, 2.82]
Induced hypothermia (*N* = 1566)	637 (40.7%)	1.60 (1.43, 1.78)	1.36 [1.01, 1.83]

Post-arrest catheterization associated with improved outcomes – effect size greater than for TTM



Important secondary result: survival is greater if post-arrest volume is larger

Benefit of prompt post-arrest PCI

2014

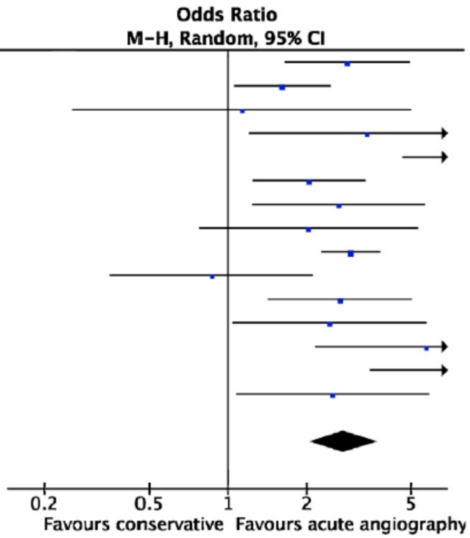
Cardiac catheterization is associated with superior outcomes for survivors of out of hospital cardiac arrest: Review and meta-analysis☆

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

Study or Subgroup	Acute angiography Events	Acute angiography Total	No acute Angiography Events	No acute Angiography Total	Weight	Odds Ratio 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%	9.93 [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 ($P < 0.00001$)



Angiography associated with improved survival

Similar results for both survival and good neurologic outcome

Most studies from 2010 onward (post-arrest TTM era)

Acknowledgements

Center for Resuscitation Science

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Kelsey Sheak
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West Philadelphia – Penn campus