

Post-Cardiac Arrest Syndrome

Benjamin S. Abella
Bentley J. Bobrow

REFERENCES

- Neumar RW, Shuster M, Callaway CW, et al: Part 1: Executive Summary: 2015 American Heart Association Guidelines Update for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 132: S315, 2015. [PMID: 26472989]
- Girotra S, van Diepen S, Nallamothu BK, et al: Regional variation in out-of-hospital cardiac arrest survival in the United States. *Circulation* 133: 2159, 2016. [PMID: 27081119]
- van Diepen S, Girotra S, Abella BS, et al: Multistate 5-year initiative to improve care for out-of-hospital cardiac arrest: primary results from the HeartRescue Project. *J Am Heart Assoc* 6: 9, 2017. [PMID: 28939711]
- Moulaert VR, Verbunt JA, van Heugten CM, Wade DT: Cognitive impairments in survivors of out-of-hospital cardiac arrest: a systematic review. *Resuscitation* 80: 297, 2009. [PMID: 19117659]
- Lim C, Alexander MP, LaFleche G, Schnyer DM, Verfaellie M: The neurological and cognitive sequelae of cardiac arrest. *Neurology* 63: 1774, 2004. [PMID: 15557489]
- Nunnally ME, Jaeschke R, Bellinger DJ, et al: Targeted temperature management in critical care: a report and recommendations from five professional societies. *Crit Care Med* 39: 1113, 2011. [PMID: 21187745]
- Angelos MG, Yeh ST, Aune SE: Post-cardiac arrest hyperoxia and mitochondrial function. *Resuscitation* 82(Suppl 2): S48, 2011. [PMID: 22208178]
- Neumar RW, Nolan JP, Adrie C, et al: Post-cardiac arrest syndrome: epidemiology, pathophysiology, treatment, and prognostication. A consensus statement from the International Liaison Committee on Resuscitation (American Heart Association, Australian and New Zealand Council on Resuscitation, European Resuscitation Council, Heart and Stroke Foundation of Canada, InterAmerican Heart Foundation, Resuscitation Council of Asia, and the Resuscitation Council of Southern Africa); the American Heart Association Emergency Cardiovascular Care Committee; the Council on Cardio-vascular Surgery and Anesthesia; the Council on Cardiopulmonary, Perioperative, and Critical Care; the Council on Clinical Cardiology; and the Stroke Council. *Circulation* 118: 2452, 2008. [PMID: 20129438]
- Vanden Hoek TL, Qin Y, Wojcik K, et al: Reperfusion, not simulated ischemia, initiates intrinsic apoptosis injury in chick cardiomyocytes. *Am J Physiol Heart Circ Physiol* 284: H141, 2003. [PMID: 12388298]
- Beiser DG, Orbelyan GA, Inouye BT, et al: Genetic deletion of NOS3 increases lethal cardiac dysfunction following mouse cardiac arrest. *Resuscitation* 82: 115, 2011. [PMID: 20951489]
- Beiser DG, Wojcik KR, Zhao D, Orbelyan GA, Hamann KJ, Vanden Hoek TL: Akt1 genetic deficiency limits hypothermia cardioprotection following murine cardiac arrest. *Am J Physiol Heart Circ Physiol* 298: H1761, 2010. [PMID: 20363892]
- Samborska-Sabluk A, Sablik Z, Gaszynski W: The role of the immuno-inflammatory response in patients after cardiac arrest. *Arch Med Sci* 7: 619, 2011. [PMID: 22291797]
- Adrie C, Laurent I, Monchi M, Cariou A, Dhainau JF, Spaulding C: Postresuscitation disease after cardiac arrest: a sepsis-like syndrome? *Curr Opin Crit Care* 10: 208, 2004. [PMID: 15166838]
- Gaieski DF, Abella BS, Goyal M: CPR and postarrest care: overview, documentation, and databases. *Chest* 141: 1082, 2012. [PMID: 22474150]
- Geocadin RG, Kowalski RG: Imaging brain injury after cardiac arrest resuscitation when it really matters. *Resuscitation* 82: 1124, 2011. [PMID: 21719185]
- Zia A, Kern KB: Management of postcardiac arrest myocardial dysfunction. *Curr Opin Crit Care* 17: 241, 2011. [PMID: 21378558]
- Kern KB: Postresuscitation myocardial dysfunction. *Cardiol Clin* 20: 89, 2000. [PMID: 11845547]
- Gonzalez MM, Berg RA, Nadkarni VM, et al: Left ventricular systolic function and outcome after in-hospital cardiac arrest. *Circulation* 117: 1864, 2008. [PMID: 18378611]
- Cerchiari EL, Safar P, Klein E, Diven W: Visceral, hematologic and bacteriologic changes and neurologic outcome after cardiac arrest in dogs. The visceral post-resuscitation syndrome. *Resuscitation* 25: 119, 1993. [PMID: 8493401]
- Kim JJ, Hyun SY, Hwang SY, et al: Hormonal responses upon return of spontaneous circulation after cardiac arrest: a retrospective cohort study. *Crit Care* 15: R53, 2011. [PMID: 2129901]
- Wijdicks EF, Hijdra A, Young GB, Bassetti CL, Wiebe S: Practice parameter: prediction of outcome in comatose survivors after cardiopulmonary resuscitation (an evidence-based review): report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology* 67: 203, 2006. [PMID: 16864809]
- Callaway CW, Donnino MW, Fink EL, et al: Part 8: post-cardiac arrest care: 2015 American Heart Association guidelines update for cardiopulmonary resuscitation and emergency cardiovascular care. *Circulation* 132: S465, 2015. [PMID: 26472996]
- Skrifvars MB, Parr MJ: Incidence, predisposing factors, management and survival following cardiac arrest due to subarachnoid haemorrhage: a review of the literature. *Scand J Trauma Resusc Emerg Med* 20: 75, 2012. [PMID: 23151345]
- Metter RB, Rittenberger JC, Guyette FX, Callaway CW: Association between a quantitative CT scan measure of brain edema and outcome after cardiac arrest. *Resuscitation* 82: 1180, 2011. [PMID: 21592642]
- Sugimori H, Kanna T, Yamashita K, et al: Early findings on brain computed tomography and the prognosis of post-cardiac arrest syndrome: application of the score for stroke patients. *Resuscitation* 83: 848, 2012. [PMID: 2227499]
- Greer D, Scripko P, Bartscher J, et al: Clinical MRI interpretation for outcome prediction in cardiac arrest. *Neurocrit Care* 17: 240, 2012. [PMID: 22565633]
- Geocadin RG: Understanding and enhancing functional outcomes after cardiac arrest: the need for a multidisciplinary approach to refocus on the brain. *Resuscitation* 80: 153, 2009. [PMID: 19150289]
- Seder DB, Fraser GL, Robbins T, Libby L, Riker RR: The bispectral index and suppression ratio are very early predictors of neurological outcome during therapeutic hypothermia after cardiac arrest. *Intensive Care Med* 36: 281, 2010. [PMID: 19847399]
- Leary M, Fried DA, Gaieski DF, et al: Neurologic prognostication and bispectral index monitoring after resuscitation from cardiac arrest. *Resuscitation* 81: 1133, 2010. [PMID: 20598422]
- Rothstein TL: Therapeutic hypothermia and reliability of somatosensory evoked potentials in predicting outcome after cardiopulmonary arrest. *Neurocrit Care* 17: 146, 2012. [PMID: 22547039]
- Nielsen N, Hovdenes J, Nilsson F, et al: Outcome, timing and adverse events in therapeutic hypothermia after out-of-hospital cardiac arrest. *Acta Anaesthesiol Scand* 53: 926, 2009. [PMID: 19549271]
- The Hypothermia after Cardiac Arrest Study Group: Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. *N Engl J Med* 346: 549, 2002. [PMID: 11856793]
- Bernard SA, Gray TW, Buist MD, et al: Treatment of comatose survivors of out-of-hospital cardiac arrest with induced hypothermia. *N Engl J Med* 346: 557, 2002. [PMID: 11856794]
- Geocadin RG, Wijdicks E, Armstrong MJ, et al: Practice guideline summary: Reducing brain injury following cardiopulmonary resuscitation: Report of the Guideline Development, Dissemination, and Implementation Subcommittee of the American Academy of Neurology. *Neurology* 88: 2141, 2017. [PMID: 28490655]
- Sagalyn E, Band RA, Gaieski DF, Abella BS: Therapeutic hypothermia after cardiac arrest in clinical practice: review and compilation of recent experiences. *Crit Care Med* 37 (7 Suppl): S223, 2009. [PMID: 19535950]
- Lundby JB, Rai M, Ramu B, et al: Therapeutic hypothermia is associated with improved neurologic outcome and survival in cardiac arrest survivors of non-shockable rhythms. *Resuscitation* 83: 202, 2012. [PMID: 21864480]
- Testori C, Sterz F, Behringer W, et al: Mild therapeutic hypothermia is associated with favourable outcome in patients after cardiac arrest with non-shockable rhythms. *Resuscitation* 82: 1162, 2011. [PMID: 21705132]
- Peberdy MA, Callaway CW, Neumar RW, et al: Part 9: post-cardiac arrest care: 2010 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 122(18 Suppl 3): S768, 2010. [PMID: 20956225]
- Nielsen N, Wetterslev J, Cronberg T, et al: Targeted temperature management at 33°C versus 36°C after cardiac arrest. *N Engl J Med* 369: 2197, 2013. [PMID: 24237006]
- Bray JE, Stub D, Bloom JE, et al: Changing target temperature from 33°C to 36°C in the ICU management of out-of-hospital cardiac arrest: a before and after study. *Resuscitation* 113: 36, 2017. [PMID: 28159575]
- Rittenberger JC, Kelly E, Jang D, Greer K, Heffner A: Successful outcome utilizing hypothermia after cardiac arrest in pregnancy: a case report. *Crit Care Med* 36: 1354, 2008. [PMID: 18379264]
- Jacobs R, Honore PM, Hosseinpour N, Nieboer K, Spanen HD: Sudden cardiac arrest during pregnancy: a rare complication of acquired maternal diaphragmatic hernia. *Acta Clin Belg* 67: 198, 2012. [PMID: 22897068]
- Hsu CH, Haac B, McQuillan KA, Tisherman SA, Scalea TM, Stein DM: Outcome of suicidal hanging patients and the role of targeted temperature management in hanging-induced cardiac arrest. *J Trauma Acute Care Surg* 82: 387, 2017. [PMID: 27787437]
- <http://www.med.upenn.edu/resuscitation/hypothermia/protocols.html>. (Hypothermia Protocols. Center for Resuscitation Science. Perelman School of Medicine, University of Pennsylvania.) Accessed September 20, 2018.
- Jarrah S, Dziodzio J, Lord C, et al: Surface cooling after cardiac arrest: effectiveness, skin safety, and adverse events in routine clinical practice. *Neurocrit Care* 14: 382, 2011. [PMID: 21249528]
- Hachimi-Idrissi S, Corne L, Ebinger G, et al: Mild hypothermia induced by a helmet device: a clinical feasibility study. *Resuscitation* 52: 275, 2001. [PMID: 11738778]
- Wang H, Olivero W, Lanzino G: Rapid and selective cerebral hypothermia achieved using a cooling helmet. *J Neurosurg* 100: 272, 2004. [PMID: 15086235]
- Bernard S, Buist M, Monteiro O, et al: Induced hypothermia using large volume, iced-cold intravenous fluid in comatose survivors of out-of-hospital cardiac arrest: a preliminary report. *Resuscitation* 56: 9, 2003. [PMID: 12505732]
- Kriegel A, Janata A, Wandaller C, et al: Cold infusions alone are effective for induction of therapeutic hypothermia but do not keep patients cool after cardiac arrest. *Resuscitation* 73: 46, 2007. [PMID: 17241729]
- Merchant RM, Abella BS, Peberdy MA, et al: Therapeutic hypothermia after cardiac arrest: unintentional overcooling is common using ice packs and conventional cooling blankets. *Crit Care Med* 34(12 Suppl): S490, 2006. [PMID: 17114983]
- Rosman J, Hentzien M, Dramé M, et al: A comparison between intravascular and traditional cooling for inducing and maintaining temperature control in patients following cardiac arrest. *Anaesth Crit Care Pain Med* 37: 129, 2018. [PMID: 27913267]

52. Mirzoyev SA, McLeod CJ, Bunch TJ, Bell MR, White RD: Hypokalemia during the cooling phase of therapeutic hypothermia and its impact on arrhythmogenesis. *Resuscitation* 81: 1632, 2010. [PMID: 20828913]
53. Gaieski DF, Band RA, Abella BS, et al: Early goal-directed hemodynamic optimization combined with therapeutic hypothermia in comatose survivors of out-of-hospital cardiac arrest. *Resuscitation* 80: 418, 2009. [PMID: 19217200]
54. Nishiyama N, Sato T, Aizawa Y, Nakagawa S, Kanki H: Extreme QT prolongation during therapeutic hypothermia after cardiac arrest due to long QT syndrome. *Am J Emerg Med* 30: 638, 2012. [PMID: 21459539]
55. Arrich J: Clinical application of mild therapeutic hypothermia after cardiac arrest. *Crit Care Med* 35: 1041, 2007. [PMID: 17334257]
56. Jacobs S: Whole-body hypothermia for neonatal hypoxic-ischemic encephalopathy reduces mortality into childhood. *J Pediatr* 161: 968, 2012. [PMID: 23095697]
57. Moler FW, Silverstein FS, Holubkov R, et al: Therapeutic hypothermia after in-hospital cardiac arrest in children. *N Engl J Med* 376: 318, 2017. [PMID: 28118559]
58. Nichol G, Aufderheide TP, Eigel B, et al: Regional systems of care for out-of-hospital cardiac arrest: a policy statement from the American Heart Association. *Circulation* 121: 709, 2010. [PMID: 20075331]
59. Kim F, Nichol G, Maynard C, et al: Effect of prehospital induction of mild hypothermia on survival and neurological status among adults with cardiac arrest: a randomized clinical trial. *JAMA* 311: 45, 2014. [PMID: 24240712]
60. Bernard SA, Smith K, Cameron P, et al: Induction of therapeutic hypothermia by paramedics after resuscitation from out-of-hospital ventricular fibrillation cardiac arrest: a randomized controlled trial. *Circulation* 122: 737, 2010. [PMID: 20679551]
61. Lindsay PJ, Buell D, Scales DC: The efficacy and safety of pre-hospital cooling after out-of-hospital cardiac arrest: a systematic review and meta-analysis. *Crit Care* 22: 66, 2018. [PMID: 29534742]
62. Gonzalez MR, Esposito EC, Leary M, et al: Initial clinical predictors of significant coronary lesions after resuscitation from cardiac arrest. *Ther Hypothermia Temp Manag* 2: 73, 2012. [PMID: 24717160]
63. Rab T, Kern KB, Tamis-Holland JE, et al: Cardiac arrest: a treatment algorithm for emergent invasive cardiac procedures in the resuscitated comatose patient. *J Am Coll Cardiol* 66: 62, 2015. [PMID: 26139060]