

Bölüm 91

KARDİYOPULMONER VE KARDİYOSEREBRAL RESÜSİTASYON

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GİRİŞ

Kardiyopulmoner resüsitasyon (KPR), her hekim özellikle yoğun bakımda çalışan hekimler için temel bir beceri olmalıdır. Amerika Birleşik Devletleri'nde her yıl 200.000 kişinin hastane içi kardiyak arrest yaşadığı tahmin edilmektedir ki bunların yarısı yoğun bakım ünitelerinde (YBÜ) meydana gelmektedir (1). Hastanede resusite edilen hastaların %40-%50'sinde spontan dolaşımın geri dönüşü (SDGD) sağlanabilmekle birlikte bu hastaların yalnızca %15-20'si sağ kalmaktadır (2).

Bu veriler hala kardiyak arrestin medikal tedavisinin oldukça zor olduğunu ortaya koymakta aynı zamanda kardiyak arrest yönetiminin önemli iki farklı aşamadan oluştuğuna işaret etmektedir: kardiyopulmoner resusitasyon ve kardiyak arrest sonrası bakım. Her iki aşamada da yalnızca en uygun tedavi olumlu sonuçlar verecektir ki bu konudaki bilgilerimiz sürekli olarak artmaktadır. 1992 yılında, dünyadaki resüsitasyon organizasyonları arasında fikir birliği sağlamak amacıyla kurulan Uluslararası Resüsitasyon İrtibat Komitesi (ILCOR), beş yılda bir KPR'da son ilerlemelerin değerlendirildiği ve tedavi önerilerinin verildiği bir dizi toplantı yapmaktadır (3). "Consensus on Science" (bilimsel iş birliği) adı verilen bu önerilere dayalı olarak KPR için uluslararası kılavuz yayınlanmaktadır; en son kılavuz 2015 yılında yayınlanmıştır (4). Aşağıdaki KPR değerlendirmeleri bu kılavuzlara dayalıdır ve yetişkin hastalarda KPR'ye odaklanmaktadır.

Kardiyak Arestin Patofizyolojisi

Kardiyak arrestin altında yatan çok çeşitli etiyolojiler vardır (Tablo 1) (5). Hastane dışı kardiyak arrestlerin büyük bir çoğunluğunda neden akut miyokard enfarktüsüdür (6). Hastane içi kardiyak arrestte ise sıklıkla neden daha komplekstir. Genellikle hastanede yatan hastaların genel durumu daha kötüdür. Bu nedenle diğer iç patolojiler önem kazanmaktadır. Kardiyak arrest, sıklıkla son olaydan önce mevcut olan solunum yetmezliği veya hemodinamik instabilite ile daha subakut olarak gelişir (2).

Tablo 1. Kardiak arrest nedenleri

Kardiyak	Miyokard infarktüsü Kardiyomiyopati Kapak hastalıkları Doğumsal kalp hastalıkları Primer elektrofizyolojik anomaliler
Non-kardiyak	Pulmoner emboli Kanama Akciğer hastalıkları Metabolik-elektrolit bozuklukları Travma İntoksikasyon

Etyolojiye bakılmaksızın son yaygın yol kardiyak mekanik aktivitenin durmasıdır. Buna karşılık pek çok olguda kardiyak elektriksel aktivite başlangıçta korunmaktadır. Terapötik ve prognostik hususlar için elektriksel aktivitenin paterni son

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faktörler (yaş, cinsiyet, sağlık durumu) ve arrest sırasındaki faktörler (kardiyak arrest süresi, başlangıç ritmi) göz önüne alınmalıdır, ancak prognoz büyük ölçüde hastanın kardiyak arrest sonrası değerlendirilmesine dayalıdır. Bununla birlikte özellikle terapötik hipotermi ile tedavi edilen hastalarda farklı testlerin güvenilirliği hakkında devam eden bir tartışma vardır.

Bugün prognozun tek bir parametreye değil daha çok multimodal bir yaklaşıma dayalı olması gerektiği konusunda konsensus vardır. Ayrıca yeniden ısıtmadan sonraki 72 saatten önce kötü sonucu belirlemenin özellikle zor olduğu konusunda konsensus vardır.

KPR klavuzları ile ilgili yayınlanan çeşitli meta-analizler ile yeni bilgiler elde edilmiştir (71). Arrest sonrası 72 saatte pupiller ışık yanıtı yokluğu ile birlikte arrest sonrası herhangi bir anda medyan sinir somatosensoryel uyarılmış potansiyellerin (N20 kortikal yanıtı) bilateral yokluğu yüksek bir spesifite ile kötü sonucu ön görmektedir. 72. saatte korneal reflekslerin yokluğu, 72. saatte ağrıya ekstensör yanıt varlığı veya motor yanıt yokluğu ile herhangi bir anda patlama baskılamalı elektroensefalogram paterni varlığı da kötü sonucu düşündürür, ancak sensitivite düşüktür. Nöron spesifik enolaz veya astroglial protein S-100 serum düzeyleri ile ilgili olarak kötü sonucu belirleyecek açık bir cut-off değeri yoktur. Ancak serum düzeyleri düşük olduğunda maksimum terapötik çabalara devam edilmelidir. Bilgisayarlı tomografi veya manyetik rezonans görüntülemenin kullanımını konusunda daha fazla çalışmaya ihtiyaç vardır.

SONUÇ

Modern resüsitasyon kavramının gelişmeye başlamasının üzerinden yaklaşık 60 yıl geçmiş olup konuyla ilgili bilgiler sürekli yenilenmektedir. Tüm KPR uygulayıcılarının bu güncel bilgileri takip etmeleri özellikle düzenli aralıklarla yayınlanan kılavuzlara uygun müdahalede bulunmaları şüphesiz ki KPR kalitesini artıracak ve prognozda iyileşmeye neden olacaktır.

Anahtar Kelimeler: KPR, kardiyopulmoner, kardiyoserebral, resüsitasyon, arrest

KAYNAKÇA

1. National Center for Health Statistics. Health, United States, 2012: with special feature on emergency care. Hyattsville; 2013.
2. Nadkarni VM, Larkin GL, Peberdy MA, Carey SM, Kaye W, Mancini ME, et al. First documented rhythm and clinical outcome from in-hospital cardiac arrest among children and adults. JAMA. 2006;295:50-57.
3. Olasveengen TM, de Caen AR, Mancini ME, et al. Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations Summary. Resuscitation. 2017; 121: 201-214.
4. American Heart Association. 2010 American Heart Association for cardiopulmonary resuscitation and emergency cardiovascular care. Circulation. 2010;122:640-946.
5. Pell JP, Sirel JM, Marsden AK, Ford I, Walker NL, Cobbe SM. Presentation, management, and outcome of out of hospital cardiopulmonary arrest: comparison by underlying aetiology. Heart. 2003;89:839-842.
6. Spaulding CM, Joly LM, Rosenberg A, Monchi M, Weber SN, Dhainaut JF, et al. Immediate coronary angiography in survivors of out-of-hospital cardiac arrest. N Engl J Med. 1997;336:1629
7. Berg RA, Sorrell VL, Kern KB, Hilwig RW, Altbach MI, Hayes MM, et al. Magnetic resonance imaging during untreated ventricular fibrillation reveals prompt right ventricular overdistention with out left ventricular volume loss. Circulation. 2005;111:1136-1140.
8. Miyamoto O, Auer RN. Hypoxia, hyperoxia, ischemia, and brain necrosis. Neurology. 2000;54:362-371.
9. Rossen R, Kabat H, Anderson JP. Acute arrest of cerebral circulation in man. Arch Neurol Psychiatry. 1943;50:510-528.
10. Cavus E, Bein B, Dörge V, Stadlbauer KH, Wenzel V, Steinfath M, et al. Brain tissue oxygen pressure and cerebral metabolism in an animal model of cardiac arrest and cardiopulmonary resuscitation. Resuscitation. 2006;71:97-106.
11. LaManna JC, Griffith JK, Cordisco BR, Bell HE, Lin CW, Pundik S, et al. Rapid recovery of rat brain intracellular pH after cardiac arrest and resuscitation. Brain Res. 1995;687:175-181.
12. Benveniste H, Drejer J, Schousboe A, Diemer NH. Elevation of the extracellular concentrations of glutamate and aspartate in rat hippocampus during transient cerebral ischemia monitored by intracerebral microdialysis. J Neurochem. 1984;43:1369-1374.
13. DeGracia DJ, O'Neil BJ, Neumar RW, Grossman LI, et al. Brain ischemia and reperfusion: molecular mechanisms of neuronal injury. J Neurol Sci. 2000;179:1-33.
14. Kalimo H, Garcia JH, Kamijyo Y, Tanaka J, Trump BF. The ultra-structure of "brain death". II. Electron microscopy of feline cortex after complete ischemia. Virchows Arch B Cell Pathol. 1977;25:207-220.
15. Tanaka K, Shirai T, Nagata E, Dembo T, Fukuuchi Y. Immunohistochemical detection of nitrotyrosine in postischemic cerebral cortex in gerbil. Neurosci Lett. 1997;235:85-88.
16. Padosch SA, Popp E, Vogel P, Böttiger BW. Altered protein expression levels of Fas/CD95 and Fas ligand in

- differentially vulnerable brain areas in rats after global cerebral ischemia. *Neurosci Lett.* 2003;338:247–251.
17. Teschendorf P, Padosch SA, Spöhr F, Albertsmeier M, Schneider A, Vogel P, et al. Time course of caspase activation in selectively vulnerable brain areas following global cerebral ischemia due to cardiac arrest in rats. *Neurosci Lett.* 2008;448:194–199.
 18. Lim C, Alexander MP, LaFleche G, Schnyer DM, Verfaellie M. The neurological and cognitive sequelae of cardiac arrest. *Neurology.* 2004;63:1774–1778.
 19. Knapp J, Bergmann G, Bruckner T, Russ N, Böttiger BW, Popp E. Pre- and postconditioning effect of sevoflurane on myocardial dysfunction after cardiopulmonary resuscitation in rats. *Resuscitation.* 2013;84:1450–1455.
 20. Palmer BS, Hadziahmetovic M, Veci T, Angelos MG. Global ischemic duration and reperfusion function in the isolated perfused rat heart. *Resuscitation.* 2004;62:97–106.
 21. Laurent I, Monchi M, Chiche JD, Joly LM, Spaulding C, Bourgeois B, et al. Reversible myocardial dysfunction in survivors of out-of-hospital cardiac arrest. *J Am Coll Cardiol.* 2002;40: 2110–2116.
 22. Yamaguchi H, Weil MH, Tang W, Kamohara T, Jin X, Bisera J. Myocardial dysfunction after electrical defibrillation. *Resuscitation.* 2002;54:289–296.
 23. Tang W, Weil MH, Sun S, Noc M, Yang L, Gazmuri RJ. Epinephrine increases the severity of postresuscitation myocardial dysfunction. *Circulation.* 1995;92:3089–3093.
 24. Adrie C, Monchi M, Laurent I, Um S, Yan SB, Thuong M, et al. Coagulopathy after successful cardiopulmonary resuscitation following cardiac arrest: implication of the protein C anticoagulant pathway. *J Am Coll Cardiol.* 2005;46:21–28.
 25. Adrie C, Adib-Conquy M, Laurent I, Monchi M, Vinsonneau C, Fitting C, et al. Successful cardiopulmonary resuscitation after cardiac arrest as a “sepsis-like” syndrome. *Circulation.* 2002;106:562–568.
 26. Nandi PR, Charlesworth CH, Taylor SJ, Nunn JF, Doré CJ. Effect of general anaesthesia on the pharynx. *Br J Anaesth.* 1991;66: 157–162.
 27. Guildner CW. Resuscitation—opening the airway. A comparative study of techniques for opening an airway obstructed by the tongue. *JACEP.* 1976;5:588–590.
 28. Clark JJ, Larsen MP, Culley LL, Graves JR, Eisenberg MS. Incidence of agonal respirations in sudden cardiac arrest. *Ann Emerg Med.* 1992;21:1464–1467
 29. Ruppert M, Reith MW, Widmann JH, Lackner CK, Kerkmann R, Schweiberer L, et al. Checking for breathing: evaluation of the diagnostic capability of emergency medical services personnel, physicians, medical students, and medical laypersons. *Ann Emerg Med.* 1999;34:720–729.
 30. Kouwenhoven WB, Jude JR, Knickerbocker GG. Closed-chest cardiac massage. *JAMA.* 1960;173:1064–1067.
 31. Redberg RF, Tucker KJ, Cohen TJ, Dutton JP, Callahan ML, Schiller NB. Physiology of blood flow during cardiopulmonary resuscitation. A transesophageal echocardiographic study. *Circulation.* 1993;88:534–542.
 32. Rivers EP, Lozon J, Enriquez E, Havstad SV, Martin GB, Lewandowski CA, et al. Simultaneous radial, femoral, and aortic arterial pressures during human cardiopulmonary resuscitation. *Crit Care Med.* 1993;21:878–883.
 33. Ornato JP, Gonzalez ER, Garnett AR, Levine RL, McCullung BK. Effect of cardiopulmonary resuscitation compression rate on end-tidal carbon dioxide concentration and arterial pressure in man. *Crit Care Med.* 1988;16:241–245.
 34. Kern KB, Hilwig RW, Berg RA, Sanders AB, Ewy GA. Importance of continuous chest compressions during cardiopulmonary resuscitation: improved outcome during a simulated single lay-rescuer scenario. *Circulation.* 2002;105:645–649.
 35. Safar P, Escarraga LA, Elam JO. A comparison of the mouth-to-mouth and mouth-to-airway methods of artificial respiration with the chest-pressure arm-lift methods. *N Engl J Med.* 1958;258:671–677.
 36. Brenner BE, Van DC, Cheng D, Lazar EJ. Determinants of reluctance to perform CPR among residents and applicants: the impact of experience on helping behavior. *Resuscitation.* 1997;35:203–211.
 37. Quintana S, Martínez Pérez J, Alvarez M, Vila JS, Jara F, Nava JM. Maximum FIO₂ in minimum time depending on the kind of resuscitation bag and oxygen flow. *Intensive Care Med.* 2004;30:155–158.
 38. Redfern D, Rassam S, Stacey MR, Mecklenburgh JS. Comparison of face masks in the bag-mask ventilation of a manikin. *Eur J Anaesthesiol.* 2006;23:169–172.
 39. Stone BJ, Chantler PJ, Baskett PJF. The incidence of regurgitation during cardiopulmonary resuscitation: a comparison between the bag valve mask and laryngeal mask airway. *Resuscitation.* 1998;38:3–6.
 40. Timmermann A, Eich C, Russo SG, Natge U, Bräuer A, Rosenblatt WH, et al. Prehospital airway management: a prospective evaluation of anaesthesia trained emergency physicians. *Resuscitation.* 2006;70:179–185.
 41. Aufderheide TP, Lurie KG. Death by hyperventilation: a common and life-threatening problem during cardiopulmonary resuscitation. *Crit Care Med.* 2004;32:345–351.
 42. Dorph E, Wik L, Strømme TA, Eriksen M, Steen PA. Quality of CPR with three different ventilation:compression ratios. *Resuscitation.* 2003;58:193–201.
 43. Babbs CF, Kern KB. Optimum compression to ventilation ratios in CPR under realistic, practical conditions: a physiological and mathematical analysis. *Resuscitation.* 2002;54:147–157.
 44. Driscoll TE, Ratnoff OD, Nygaard OF. The remarkable Dr. Abildgaard and countershock. The bicentennial of his electrical experiments on animals. *Ann Intern Med.* 1975;83:878–882.
 45. Lown B, Neuman J, Amarasingham R, Berkovits BV. Comparison of alternating current with direct electroshock across the closed chest. *Am J Cardiol.* 1962;10:223–233.
 46. Chattipakorn N, Banville I, Gray RA, Ideker RE. Mechanism of ventricular defibrillation for near-defibrillation threshold shocks: a whole-heart optical mapping study in swine. *Circulation.* 2001;104:1313–1319.
 47. Waalewijn RA, de Vos R, Tijssen JGP, Koster RW. Survival models for out-of-hospital cardiopulmonary resuscitation from the perspectives of the bystander, the

- first responder, and the para- medic. Resuscitation. 2001;51:113–122.
48. Hallstrom AP, Ornato JP, Weisfeldt M, et al. Public Access Defibrillation Trial Investigators. Public-access defibrillation and survival after out-of-hospital cardiac arrest. *N Engl J Med.* 2004;351:637–646.
 49. Kitamura T, Iwami T, Kawamura T, Nagao K, Tanaka H, Hiraide A. Nationwide public-access defibrillation in Japan. *N Engl J Med.* 2010;362:994–1004.
 50. Skulec R, Belohlavek J, Kovarnik T, Kolar J, Gandalovicova J, Dytrych V, et al. Serum cardiac markers response to biphasic and monophasic electrical cardioversion for supraventricular tachyarrhythmia—a randomised study. *Resuscitation.* 2006;70:423–431.
 51. Ambler JJS, Deakin CD. A randomised controlled trial of the effect of biphasic or monophasic waveform on the incidence and severity of cutaneous burns following external direct current cardioversion. *Resuscitation.* 2006;71:293–300.
 52. Kudenchuk PJ, Cobb LA, Copass MK, Olsufka M, Maynard C, Nichol G. Transthoracic incremental monophasic versus biphasic defibrillation by emergency responders (TIMBER): a randomized comparison of monophasic with biphasic waveform ascending energy defibrillation for the resuscitation of out-of-hospital cardiac arrest due to ventricular fibrillation. *Circulation.* 2006;114:2010–2018.
 53. Faddy SC, Powell J, Craig JC. Biphasic and monophasic shocks for transthoracic defibrillation: a meta analysis of randomised controlled trials. *Resuscitation.* 2003;58:9–16.
 54. Herweling A, Karmrodt J, Stepniak A, Fein A, Baumgardner JE, Eberle B, et al. A novel technique to follow fast PaO₂ variations during experimental CPR. *Resuscitation.* 2005;65:71–78.
 55. Glaeser PW, Hellmich TR, Szewczuga D, Losek JD, Smith DS. Five-year experience in prehospital intraosseous infusions in children and adults. *Ann Emerg Med.* 1993;22:1119–1124.
 56. Caldwell G, Millar G, Quinn E, Vincent R, Chamberlain DA. Simple mechanical methods for cardioversion: defence of the precordial thump and cough version. *Br Med J.* 1985;291:627–630.
 57. Rea TD, Shah S, Kudenchuk PJ, Copass MK, Cobb LA. Automated external defibrillators: to what extent does the algorithm delay CPR? *Ann Emerg Med.* 2005;46:132–141.
 58. Hess EP, White RD. Ventricular fibrillation is not provoked by chest compression during post-shock organized rhythms in out-of-hospital cardiac arrest. *Resuscitation.* 2005;66:7–11.
 59. Langhelle A, Tyvold SS, Lexow K, Hapnes SA, Sunde K, Steen PA. In-hospital factors associated with improved outcome after out-of-hospital cardiac arrest. A comparison between four regions in Norway. *Resuscitation.* 2003;56:247–263.
 60. Capes SE, Hunt D, Malmberg K, Pathak P, Gerstein HC. Stress hyperglycemia and prognosis of stroke in nondiabetic and diabetic patients: a systematic overview. *Stroke.* 2001;32:2426–2432.
 61. Van den Berghe G, Wouters P, Weekers F, Verwaest C, Bruyninckx F, Schetz M, et al. Intensive insulin therapy in critically ill patients. *N Engl J Med.* 2001;345:1359–1367.
 62. Losert H, Sterz F, Roine RO, Holzer M, Martens P, Cercihari E, et al. Strict normoglycaemic blood glucose levels in the therapeutic management of patients within 12h after cardiac arrest might not be necessary. *Resuscitation.* 2008;76:214–220.
 63. Schneider AG, Eastwood GM, Bellomo R, Bailey M, Lipscey M, Pilcher D, et al. Arterial carbon dioxide tension and outcome in patients admitted to the intensive care unit after cardiac arrest. *Resuscitation.* 2013;84:927–934.
 64. Richards EM, Fiskum G, Rosenthal RE, Hopkins I, McKenna MC. Hyperoxic reperfusion after global ischemia decreases hippocampal energy metabolism. *Stroke.* 2007;38:1578–1584.
 65. Kilgannon JH, Jones AE, Shapiro NI, Angelos MG, Milcarek B, Hunter K, et al. Association between arterial hypoxia following resuscitation from cardiac arrest and in-hospital mortality. *JAMA.* 2010;303:2165–2171.
 66. Hypothermia after Cardiac Arrest Study Group. Mild therapeutic hypothermia to improve the neurologic outcome after cardiac arrest. *N Engl J Med.* 2002;346:549–556.
 67. Nielsen N, Wetterslev J, Cronberg T, Erlinge D, Gasche Y, Hassager C, et al. Targeted temperature management at 33°C versus 36°C after cardiac arrest. *N Engl J Med.* 2013;369:2197–2206.
 68. International Liaison Committee on Resuscitation [Internet]. Targeted temperature management following cardiac arrest. An update. 17 Dec 2013 [cited 8 Mar 2014]. Available from: <http://www.ilcor.org/data/TTM-ILCOR-update-Dec-2013.pdf>.
 69. Virkkunen I, Yli-Hankala A, Silfvast T. Induction of therapeutic hypothermia after cardiac arrest in prehospital patients using ice-cold Ringer's solution: a pilot study. *Resuscitation.* 2004;62: 299–302.
 70. Sessler DI. Mild perioperative hypothermia. *N Engl J Med.* 1997;336:1730–1737.
 71. Sandroni C, Cavallaro F, Callaway CW, Sanna T, D'Arigo S, Kuiper M, et al. Predictors of poor neurological outcome in adult comatose survivors of cardiac arrest: a systematic review and meta-analysis. Part 1: Patients not treated with therapeutic hypothermia. *Resuscitation.* 2013;84:1310–1323.