

GİRİŞ

KPR gerçekleştirilirken arreste neden olan geri dönüşü olası etmenler mümkün olan en kısa sürede ve en iyi şekilde tedavi edilmelidir. Geri dönüşü olan kardiyak arrest nedenleri 4H-4T kısaltması başlıklar altında toplanmıştır. **4H** içerisinde **Hipoksi**, **Hipo/hiperkalemi** ve diğer elektrolit bozuklukları, **Hipo/Hipertermi** ve **Hipovolemi** yer almaktadır. Ayrıca bu bölümde hipovolemiye neden olan anafilaksi ve travmatik kardiyak arrest de ele alınacaktır.

4H

HİPOKSI

Vücut içinde veya dışında herhangi bir yerde oksijen basıncının azalması, doku ve organların yetersiz oksijenlenmesi ya da hücre fonksiyonları için yetersiz oksijen sağlanması veya vital organlara oksijen sunumunun azalması olarak tanımlanan, geniş anlamları olan hipoksi hastaların medikal durumunda ciddi değişikliğe neden olur. Yükseklik hastalığında olduğu gibi atmosferdeki oksijen eksikliği ya da akciğerlere ulaşan oksijenin çeşitli sebeplere bağlı yetersiz olması (örn: obstrüksiyon), akciğerlerin yeterli ventilasyonuna müdaхale eden akciğer hastalıkları, anemi veya dolaşım yetersizliği, dokulara oksijen taşınması ve sunumunda yetmezlik, kılcal damarlar ve dokular arasındaki oksijen ve karbon dioksit değişimini bozan dokuların ödemi, solunum merkezini etkileyen durumlar, sinir kas hastalıkları ve diğer pek çok anormal durum hipoksisiye neden olabilir. Saf hipoksemi nedeniyle kardiyak arrest nadirdir. Sıklıkla, kardiyak arrest asfiksinin (vücutun oksijenden yoksun kalması) bir sonucu olarak görülür ve kardiyak arrestin kardiyak olmayan nedenlerinin çoğundan sorumludur (1).

Asfiksyal Kardiyak Arrest Nedenleri

- Hava yolu obstrüksiyonu (yumuşak dokular -koma, laringospazm, aspirasyon)
- Anemi
- Astım
- Çığ altında kalma
- Santral hipoventilasyon - beyin veya spinal kord hasarı
- KOAH
- Boğulma
- Asılma
- Yüksek irtifa
- Nöromüsküller hastalık nedeniyle alveolar ventilasyon bozukluğu

Karbon monoksit: Karbon monoksid (KO) zehirlenmesi ile ABD'de her yıl 25000 olgu hastaneye kabul edilmektedir (102). KO düzeyleri ile başlangıç semptomları veya geç sonuçlar ilişkili değildir. Tedavide mümkün olur olmaz oksijen verilmelidir. Olumsuz nörolojik sonuçları azaltmak için hiperbarik oksijen kullanılmasına karşın, iki Cochrane derlemede, bu tedavinin ikna edici bir yararı gösterilememiştir (103). KA sonrası hiperbarik oksijen merkezlerine transportun yararı kanıtlanmadığından, bu karar olgu bazında verilmelidir. KO'ya bağlı miyokardial hasar gelişen hastalarda, olaydan sonraki en az 7 yıl boyunca kardiak mortalite risinde artış nedeniyle kardiyolojik izlem önerilmektedir (104).

Kaynaklar

1. Safar P, Paradis NA, Weil MH. Asphyxial cardiac arrest. In: Paradis NA, Halperin HR, Kern KB, Wenzel V, Chamberlain DA, editors. Cardiac arrest – the science and practice of resuscitation medicine. 2nd ed. Cambridge: Cambridge University Press; 2007. p. 969–93.3.
2. Farmery AD, Roe PG. A model to describe the rate of oxyhaemoglobin desaturation during apnoea. Br J Anaesth 1996;76:284–91.
3. DeBehnke DJ, Hilander SJ, Dobler DW, Wickman LL, Swart GL. The hemodynamic and arterial blood gas response to asphyxiation: a canine model of pulseless electrical activity. Resuscitation 1995;30:169–75.
4. Deasy C, Bray J, Smith K, Bernard S, Cameron P, Committee VS. Hanging-associated out-of-hospital cardiac arrests in Melbourne, Australia. Emerg Med J 2013;30:38–42.
5. Ogawa T, Akahane M, Koike S, Tanabe S, Mizoguchi T, Imamura T. Out-comes of chest compression only CPR versus conventional CPR conducted by lay people in patients with out of hospital cardiopulmonary arrest witnessed by bystanders: nationwide population based observational study. BMJ 2011;342:c7106.
6. Truhlář A, Deakin CD, Soar J, et al. Cardiac arrest in special circumstances section Collaborators. Resuscitation 2015;9:148–201.
7. Khanagavi J, Gupta T, Aronow WS, et al. Hyperkalemia among hospitalized patients and association between duration of hyperkalemia and outcomes. Arch Med Sci 2014;10:251–7.
8. Surawicz B, Chlebus H, Mazzoleni A. Hemodynamic and electrocardiographic effects of hyperpotassemia. Differences in response to slow and rapid increases in concentration of plasma K. Am Heart J 1967;73:647–64.
9. El-Sherif N, Turitto G. Electrolyte disorders and arrhythmogenesis. Cardiol J 2011;18:233–45.
10. Kjeldsen K. Hypokalemia and sudden cardiac death. Exp Clin Cardiol 2010;15:e96–9.
11. Pasquier M, Zurron N, Weith B, et al. Deep accidental hypothermia with core temperature below 24 degrees c presenting with vital signs. High Alt Med Biol 2014;15:58–63.

12. Brown DJ, Brugger H, Boyd J, Paal P. Accidental hypothermia. *N Engl J Med* 2012;367:1930–8,34.
13. Strapazzon G, Procter E, Paal P, Brugger H. Pre-hospital core temperature measurement in accidental and therapeutic hypothermia. *High Alt Med Biol* 2014;15:104–11.
14. Gordon L, Paal P, Ellerton JA, Brugger H, Peek GJ, Zafren K. Delayed and intermittent CPR for severe accidental hypothermia. *Resuscitation* 2015;90:46–9.
15. Paal P, Milani M, Brown D, Boyd J, Ellerton J. Termination of cardiopulmonary resuscitation in mountain rescue. *High Alt Med Biol* 2012;13:200–8.
16. Putzer G, Tiefenthaler W, Mair P, Paal P. Near-infrared spectroscopy during cardiopulmonary resuscitation of a hypothermic polytraumatised cardiac arrest patient. *Resuscitation* 2012;83:e1–2.
17. Nolan JP, Soar J, Wenzel V, Paal P. Cardiopulmonary resuscitation and management of cardiac arrest. *Nat Rev Cardiol* 2012;9:499–511.
18. Putzer G, Braun P, Zimmermann A, et al. LUCAS compared to manual cardiopulmonary resuscitation is more effective during helicopter rescue – a prospective, randomized, cross-over manikin study. *Am J Emerg Med* 2013;31:384–9.
19. Stoner J, Martin G, O'Mara K, Ehlers J, Tomlanovich M. Amiodarone and bretylium in the treatment of hypothermic ventricular fibrillation in a canine model. *Acad Emerg Med* 2003;10:187–91.
20. Kornberger E, Lindner KH, Mayr VD, et al. Effects of epinephrine in a pig model of hypothermic cardiac arrest and closed-chest cardiopulmonary resuscitation combined with active rewarming. *Resuscitation* 2001;50:301–8.
21. Paal P, Strapazzon G, Braun P, et al. Factors affecting survival from avalanche burial – a randomised prospective porcine pilot study. *Resuscitation* 2013;84:239–43.
22. Zafren K, Giesbrecht GG, Danzl DF, et al. Wilderness Medical Society practice guidelines for the out-of-hospital evaluation and treatment of accidental hypothermia: 2014 update. *Wilderness Environ Med* 2014;25:S66–85.
23. Henriksson O, Lundgren PJ, Kuklane K, et al. Protection against cold in pre-hospital care: wet clothing removal or addition of a vapor barrier. *Wilderness Environ Med* 2015;26:11–20.
24. Brown D, Ellerton J, Paal P, Boyd J. Hypothermia evidence. Afterdrop, and practical experience. *Wilderness Environ Med* 2015 ;26:437-9.
25. Lundgren P, Henriksson O, Naredi P, Björnström U. The effect of active warming in prehospital trauma care during road and air ambulance transportation – a clinical randomized trial. *Scand J Trauma Resusc Emerg Med* 2011;19:59.
26. Gruber E, Beikircher W, Pizzinini R, et al. Non-extracorporeal rewarming at a rate of 6.8 degrees C per hour in a deeply hypothermic arrested patient. *Resuscitation* 2014;85:e119–20.

27. Ali SZ, Taguchi A, Rosenberg H. Malignant hyperthermia. Best Pract Res Clin Anaesthesiol 2003;17:519–33.
28. Coris EE, Ramirez AM, Van Durme DJ. Heat illness in athletes: the dangerous combination of heat, humidity and exercise. Sports Med 2004;34:9–16.
29. Huerta-Alardin AL, Varon J, Marik PE. Bench-to-bedside review: rhabdomyolysis – an overview for clinicians. Crit Care 2005;9:158–69.
30. Bouchama A, Dehbi M, Chaves-Carballo E. Cooling and hemodynamic management in heatstroke: practical recommendations. Crit Care 2007;11:R54.79.
31. Nolan JP, Soar J, Cariou A, et al. European Resuscitation Council and European Society of Intensive Care Medicine Guidelines for Post-resuscitation care. Resuscitation 2015;95:201–21.
32. Al-Senani FM, Graffagnino C, Grotta JC, et al. A prospective, multicenter pilot study to evaluate the feasibility and safety of using the Cool Gard System and Icy catheter following cardiac arrest. Resuscitation 2004;62:143–50.
33. Hostler D, Northington WE, Callaway CW. High-dose diazepam facilitates core cooling during cold saline infusion in healthy volunteers. Appl Physiol Nutr Metab 2009;34:582–6.
34. Larach MG, Gronert GA, Allen GC, Brandom BW, Lehman EB. Clinical presentation, treatment, and complications of malignant hyperthermia in North America from 1987 to 2006. Anesth Analg 2010;110:498–507.
35. Muraro A, Roberts G, Worm M, et al. Anaphylaxis: guidelines from the European Academy of Allergy and Clinical Immunology. Allergy 2014;69:1026–45.
36. Soar J. Emergency treatment of anaphylaxis in adults: concise guidance. Clin Med 2009;9:181–5.
37. Panesar SS, Javad S, de Silva D, et al. The epidemiology of anaphylaxis in Europe: a systematic review. Allergy 2013;68:1353–61.
38. Worm M, Moneret-Vautrin A, Scherer K, et al. First European data from the network of severe allergic reactions (NORA). Allergy 2014;69:1397–404.
39. Gibbison B, Sheikh A, McShane P, Haddow C, Soar J. Anaphylaxis admissions to UK critical care units between 2005 and 2009. Anaesthesia 2012;67:833–9.
40. Gonzalez-Perez A, Aponte Z, Vidaurre CF, Rodriguez LA. Anaphylaxis epidemiology in patients with and patients without asthma: a United Kingdom database review. J Allergy Clin Immunol 2010;125, 1098–1104.e1.
41. Pumphrey RSH. Fatal posture in anaphylactic shock. J Allergy Clin Immunol 2003;112:451–2.
42. Simpson CR, Sheikh A. Adrenaline is first line treatment for the emergency treatment of anaphylaxis. Resuscitation 2010;81:641–2.
43. Bautista E, Simons FE, Simons KJ, et al. Epinephrine fails to hasten hemodynamic recovery in fully developed canine anaphylactic shock. Int Arch Allergy Immunol 2002;128:151–64.

44. Song TT, Nelson MR, Chang JH, Engler RJ, Chowdhury BA. Adequacy of the epinephrine auto injector needle length in delivering epinephrine to the intramuscular tissues. *Ann Allergy Asthma Immunol* 2005;94:539–42.
45. Brown SG. Cardiovascular aspects of anaphylaxis: implications for treatment and diagnosis. *Curr Opin Allergy Clin Immunol* 2005;5:359–64.
46. Sheikh A, Ten Broek V, Brown SG, Simons FE. H1-antihistamines for the treatment of anaphylaxis: Cochrane systematic review. *Allergy* 2007;62:830–7.
47. Choo KJ, Simons FE, Sheikh A. Glucocorticoids for the treatment of anaphylaxis. *Cochrane Database Syst Rev* 2010;3:CD007596.
48. Green R, Ball A. Alpha-agonists for the treatment of anaphylactic shock. *Anaesthesia* 2005;60:621–2.
49. Rocq N, Favier JC, Plancade D, Steiner T, Mertes PM. Successful use of terlipressin in post-cardiac arrest resuscitation after an epinephrine-resistant anaphylactic shock to suxamethonium. *Anesthesiology* 2007;107:166–7.
50. Schwartz LB. Diagnostic value of tryptase in anaphylaxis and mastocytosis. *Immunol Allergy Clin North Am* 2006;26:451–63.
51. Simons FE, Lieberman PL, Read Jr EJ, Edwards ES. Hazards of unintentional injection of epinephrine from auto injectors: a systematic review. *Ann Allergy Asthma Immunol* 2009;102:282–7.
52. Zwingmann J, Mehlhorn AT, Hammer T, Bayer J, Sudkamp NP, Strohm PC. Survival and neurologic outcome after traumatic out-of-hospital cardiopulmonary arrest in a pediatric and adult population: a systematic review. *Crit Care* 2012;16:R117.
53. Leis CC, Hernandez CC, Blanco MJ, Paterna PC, Hernandez Rde E, Torres EC. Traumatic cardiac arrest: should advanced life support be initiated? *J Trauma Acute Care Surg* 2013;74:634–8.
54. Engdahl J, Herlitz J. Localization of out-of-hospital cardiac arrest in Goteborg 1994–2002 and implications for public access defibrillation. *Resuscitation* 2005;64:171–5.
55. Powell DW, Moore EE, Cothren CC, et al. Is emergency department resuscitative thoracotomy futile care for the critically injured patient requiring prehospital cardiopulmonary resuscitation? *J Am Coll Surg* 2004;199:211–5.
56. Soar J, Nolan JP, Bottiger BW, et al. European Resuscitation Council Guidelines for Resuscitation 2015 Section 3. Adult advanced life support. *Resuscitation* 2015;95:99–146.
57. Spahn DR, Bouillon B, Cerny V, et al. Management of bleeding and coagulopathy following major trauma: an updated European guideline. *Crit Care* 2013;17:R76.
58. Kwan I, Bunn F, Chinnock P, Roberts I. Timing and volume of fluid administration for patients with bleeding. *Cochrane Database Syst Rev* 2014;3:CD450022.
59. Holcomb JB, Tilley BC, Baraniuk S, et al. Transfusion of plasma, platelets, and red blood cells in a 1:1:1 vs a 1:1:2 ratio and mortality in patients with severe trauma: the PROPPR randomized clinical trial. *JAMA* 2015;313:471–82.

60. CRASH-2 collaborators Roberts I, Shakur H, et al. The importance of early treatment with tranexamic acid in bleeding trauma patients: an exploratory analysis of the CRASH-2 randomised controlled trial. *Lancet* 2011;377:1096–101, 1101.e1–2.
61. Escott ME, Gleisberg GR, Kimmel K, Karrer A, Cosper J, Monroe BJ. Simple thoracostomy. Moving beyond needle decompression in traumatic cardiac arrest. *JEMS* 2014;39:26–32.
62. Burlew CC, Moore EE, Moore FA, et al. Western Trauma Association critical decisions in trauma: resuscitative thoracotomy. *J Trauma Acute Care Surg* 2012;73:1359–63.
63. Barton ED. Tension pneumothorax. *Curr Opin Pulm Med* 1999;5:269–74.
64. Roberts DJ, Leigh-Smith S, Faris PD, et al. Clinical presentation of patients with tension pneumothorax: a systematic review. *Ann Surg* 2015. Jan 5.
65. Kleber C, Giesecke MT, Lindner T, et al. Requirement for a structured algorithm in cardiac arrest following major trauma: epidemiology, management errors, and preventability of traumatic deaths in Berlin. *Resuscitation* 2014;85:405–10.
66. Clemency BM, Tanski CT, Rosenberg M, et al. Sufficient catheter length for pneumothorax needle decompression: a meta-analysis. *Prehosp Disaster Med* 2015;30:249–53.
67. Massarutti D, Trillo G, Berlot G, et al. Simple thoracostomy in prehospital trauma management is safe and effective: a 2-year experience by helicopter emergency medical crews. *Eur J Emerg Med* 2006;13:276–80.
68. The society of thoracic surgeons expert consensus for the resuscitation of patients who arrest after cardiac surgery. *Ann Thorac Surg* 2017;103:1005–20.
69. Konstantinides SV, Torbicki A, Agnelli G, et al. 2014 ESC guidelines on the diagnosis and management of acute pulmonary embolism. *Eur Heart J* 2014;35:3033–69, 69a–69k.
70. Heradstveit BE, Sunde K, Sunde GA, et al. Factors complicating interpretation of capnography during advanced life support in cardiac arrest a clinical retrospective study in 575 patients. *Resuscitation* 2012;83:813–8.
71. Bergum D, Nordseth T, Mjølstad OC, et al. Causes of in-hospital cardiac arrest-incidences and rate of recognition. *Resuscitation* 2015;87:63–8.
72. MacCarthy P, Worrall A, McCarthy G, Davies J. The use of transthoracic echocardiography to guide thrombolytic therapy during cardiac arrest due to massive pulmonary embolism. *Emerg Med J* 2002;19:178–9.
73. Roy PM, Colombet I, Durieux P, et al. Systematic review and meta-analysis of strategies for the diagnosis of suspected pulmonary embolism. *BMJ* 2005;331:259.
74. Konstantinov IE, Saxena P, Koniuszko MD, et al. Acute massive pulmonary embolism with cardiopulmonary resuscitation: management and results. *Tex Heart Inst J* 2007;34:41–5, discussion 45–6.
75. Wu JP, Gu DY, Wang S, et al. Good neurological recovery after rescue thrombolysis of presumed pulmonary embolism despite prior 100 minutes CPR. *J Thorac Dis* 2014;6:E289–93.

76. Hashiba K, Okuda J, Maejima N, et al. Percutaneous cardiopulmonary support in pulmonary embolism with cardiac arrest. *Resuscitation* 2012;83:183–7.
77. Miller AC, Rosati SF, Suffredini AF, Schrump DS. A systematic review and pooled analysis of CPR-associated cardiovascular and thoracic injuries. *Resuscitation* 2014;85:724–31.
78. Bossaert L, Perkins GD, Askitopoulou H, et al. European Resuscitation Council Guidelines for Resuscitation 2015 Section 11. The ethics of resuscitation and end-of-life decisions. *Resuscitation* 2015;95:301–10.
79. Sakamoto T, Morimura N, Nagao K, et al. Extracorporeal cardiopulmonary resuscitation versus conventional cardiopulmonary resuscitation in adults with out-of-hospital cardiac arrest: a prospective observational study. *Resuscitation* 2014; 85:762–8.
80. Forti A, Zilio G, Zanatta P, et al. Full recovery after prolonged cardiac arrest and resuscitation with mechanical chest compression device during helicopter transportation and percutaneous coronary intervention. *J Emerg Med* 2014;47:632–4.
81. Stub D, Nehme Z, Bernard S, et al. Exploring which patients without return of spontaneous circulation following ventricular fibrillation out-of-hospital cardiac arrest should be transported to hospital? *Resuscitation* 2014;85:326–31.
82. Mowry JB, Spyker DA, Cantilena Jr LR, et al. 2013 Annual Report of the American Association of Poison Control Centers' National Poison Data System (NPDS): 31st Annual Report. *Clin Toxicol (Phila)* 2014;52:1032–283.
83. Thompson TM, Theobald J, Lu J, Erickson TB. The general approach to the poisoned patient. *Dis Mon* 2014; 60:509–24.
84. Cave G, Harvey MG. Should we consider the infusion of lipid emulsion in the resuscitation of poisoned patients? *Crit Care* 2014;18:457.
85. de Lange DW, Sikma MA, Meulenbelt J. Extracorporeal membrane oxygenation in the treatment of poisoned patients. *Clin Toxicol (Phila)* 2013;51:385–93.
86. Benson BE, Hoppu K, Troutman WG, et al. Position paper update: gastric lavage for gastrointestinal decontamination. *Clin Toxicol (Phila)* 2013;51:140–6.
87. Thanacoody R, Caravati EM, Troutman B, et al. Position paper update: whole bowel irrigation for gastrointestinal decontamination of overdose patients. *Clin Toxicol (Phila)* 2015;53:5–12.
88. Skinner CG, Chang AS, Matthews AS, et al. Randomized controlled study on the use of multiple-dose activated charcoal in patients with supratherapeutic phenytoin levels. *Clin Toxicol (Phila)* 2012;50:764–9.
89. Robertson TM, Hendey GW, Stroh G, Shalit M. Intranasal naloxone is a viable alternative to intravenous naloxone for prehospital narcotic overdose. *Prehosp Emerg Care* 2009;13:512–5.
90. Nielsen K, Nielsen SL, Siersma V, Rasmussen LS. Treatment of opioid overdose in a physician-based prehospital EMS: frequency and long-term prognosis. *Resuscitation* 2011;82:1410–3.

91. Woolf AD, Erdman AR, Nelson LS, et al. Tricyclic antidepressant poisoning: an evidence-based consensus guideline for out-of-hospital management. *Clin Toxicol (Phila)* 2007;45:203–33.
92. Bradberry SM, Thanacoody HK, Watt BE, et al. Management of the cardiovascular complications of tricyclic antidepressant poisoning: role of sodium bicarbonate. *Toxicol Rev* 2005;24:195–204.
93. Harvey M, Cave G. Intralipid outperforms sodium bicarbonate in a rabbit model of clomipramine toxicity. *Ann Emerg Med* 2007;49:178–85, 185.e1–4.
94. Dattilo PB, Hailpern SM, Fearon K, et al. Beta-blockers are associated with reduced risk of myocardial infarction after cocaine use. *Ann Emerg Med* 2008;51:117–25.
95. Hsue PY, McManus D, Selby V, et al. Cardiac arrest in patients who smoke crack cocaine. *Am J Cardiol* 2007;99:822–4.
96. Di Gregorio G, Schwartz D, Ripper R, et al. Lipid emulsion is superior to vasopressin in a rodent model of resuscitation from toxin-induced cardiac arrest. *Crit Care Med* 2009;37:993–9.
97. Bailey B. Glucagon in beta-blocker and calcium channel blocker overdoses: a systematic review. *J Toxicol Clin Toxicol* 2003;41:595–602.
98. Page C, Hacket LP, Isbister GK. The use of high-dose insulin-glucose euglycemia in beta-blocker overdose: a case report. *J Med Toxicol* 2009;5:139–43.
99. St-Onge M, Dube PA, Gosselin S, et al. Treatment for calcium channel blocker poisoning: a systematic review. *Clin Toxicol (Phila)* 2014;52:926–44.
100. Borron SW, Baud FJ, Barriot P, et al. Prospective study of hydroxocobalamin for acute cyanide poisoning in smoke inhalation. *Ann Emerg Med* 2007;49:794–801, 801.e1–2.
101. Streitz MJ, Bebartha VS, Borys DJ, Morgan DL. Patterns of cyanide antidote use since regulatory approval of hydroxocobalamin in the United States. *Am J Ther* 2014;21:244–9.
102. Iqbal S, Clower JH, Boehmer TK, et al. Carbon monoxide-related hospitalizations in the U.S.: evaluation of a web-based query system for public health surveillance. *Public Health Rep* 2010;125:423–32.
103. Buckley NA, Juurlink DN, Isbister G, et al. Hyperbaric oxygen for carbon monoxide poisoning. *Cochrane Database Syst Rev* 2011;CD002041.
104. Roderique JD, Josef CS, Feldman MJ, Spiess BD. A modern literature review of carbon monoxide poisoning theories, therapies, and potential targets for therapy advancement. *Toxicology* 2015;334:45–58.