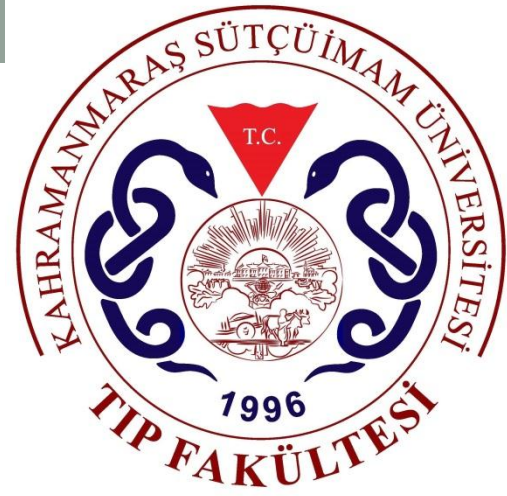




niversitemiz Senatosu'nun 13.07.2018 tarihli ve 2018/13-2 sayılı kararıyla kabul edilmiřtir.

KARBONMONOKSİT ZEHİRLLENMESİ DEĞİŞEN VAR MI?

Dr. Öğretim Üyesi ALİ İHSAN KİLCİ
KS Tıp Fakltesi Acil Tıp Anabilimdalı

2016 ACEP rehberinde;

- Karbonmonoksit zehirlenmesi için geleneksel olarak arteriyel ya da venöz kanda karboksihemoglobin (COHb) ölçümü kullanılmaktadır.
- **Noninvaziv karboksihemoglobin ölçümü önerilmiyor. Sadece hastane öncesi ölçümlerde kullanılabilir.**

- Acil hekimleri akut karbonmonoksit zehirlenmesinin tedavisinde HBO ya da yüksek akımlı normobarik oksijen kullanmalıdır(Level B).
- HBO tedavisinin, uzun dönem nörobilişsel sonuçları iyileştirmek için normobarik oksijen tedavisinden üstün olup olmadığı belirsizliğini koruyor.

- Karbonmonoksit zehirlenmesinde bulguların kan karboksihemoglobin düzeyleri ile (her ne kadar düzeye göre HBO önerenler olsa da) korele olmadığını bilmeliyiz. Özellikle geç gelen olgularda kötü klinik bulgulara rağmen COHb düzeyleri normal bile olabilir.

- Hastaların ciddiyeti aşağıdaki gibi değerlendirilebilir.
- *Hafif zehirlenme*: COHb > %10 Klinik semptom ve bulgular olamadan
- *Orta zehirlenme*: COHb > %10 hafif belirti/bulgular (Baş ağrısı, letarji, yorgunluk)
- *Ağır zehirlenme*: COHb > %20-25 bilinç kaybı, konfüzyon ya da kardiyak iskemi bulguları

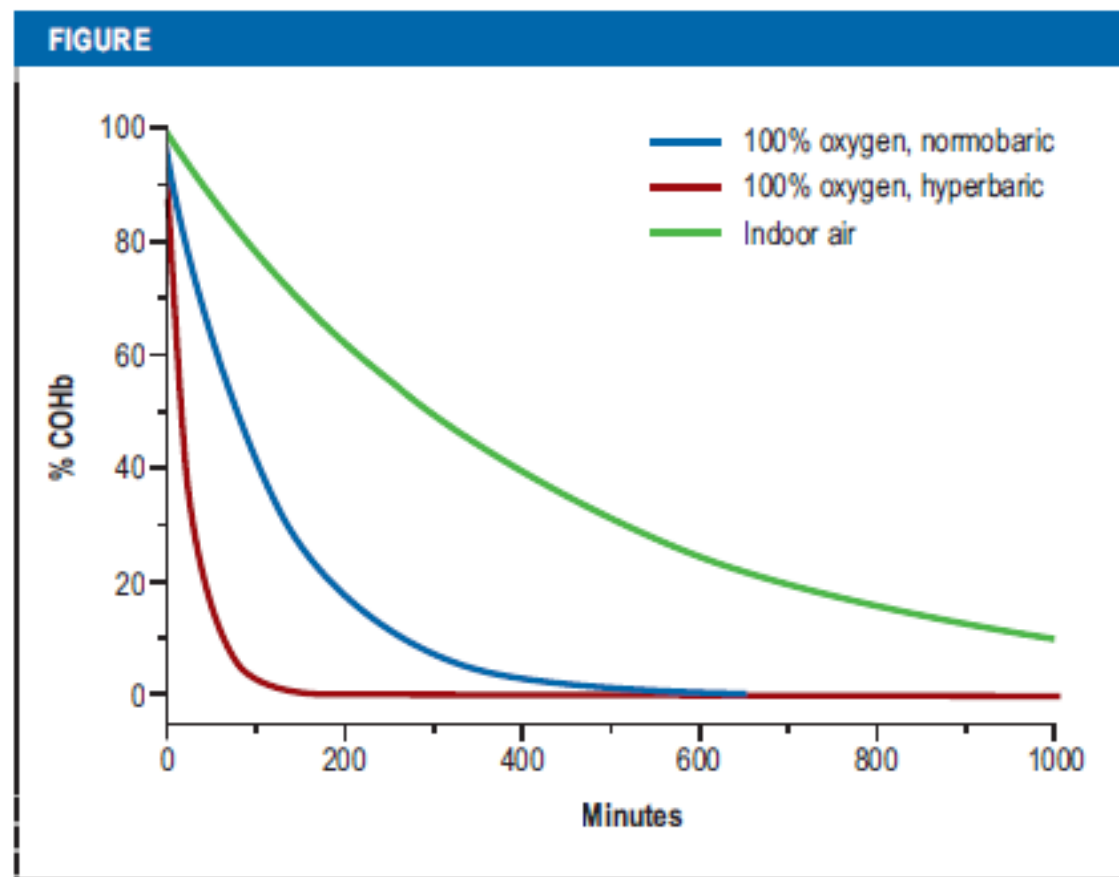
- Acil serviste şüpheli ya da tanı konan olgulara maske ile yüksek akımlı oksijen başlamak ilk tedavi yaklaşımı.
- HBO tedavisi halen net endikasyonları bilinmeyen bir alternatif tedavidir. Bu tedaviye hasta bazlı karar vermek gerekir.
- Tedaviye ulaşılabilirlik, hastanın basınç odasında kalmasının uygunluğu gibi durumlar göz önüne alınmalıdır.

- Nörolojik bulguları olan hastalarda Beyin BT'de beyin ödemi, fokal lezyonlar veya daha sık ve tipik olarak bazal ganglionlarda düşük dansiteli lezyonlar saptanabilir.
- Ancak daha iyisi difüzyon MR görüntülemesinde fokal lezyonlar veya bazal gangliyonlarda bilateral difüzyon kısıtlılığı saptanabilir

The Diagnosis and Treatment of Carbon Monoxide Poisoning

Lars Eichhorn, Marcus Thudium, Björn Jüttner

- Nörolojik defisiti, bilinç kaybı, kardiyak iskemisi, hamilelik ve / veya çok yüksek COHb konsantrasyonuna sahip hastalarda hiperbarik oksijen tedavisi (HBOT) kritik olarak düşünülmeli ve **altı saat içinde** başlatılmalıdır. 24 saatten sonra hiçbir koşulda önerilmemektedir.
- Her zehirlenme olgusunun bilişsel skalası zehirlenmeden 4-6 hafta sonrasında test edilmelidir.



Decrease in carboxyhemoglobin (COHb) under different therapeutic conditions (2). half-life for indoor air (320 min), 100% normobaric oxygen respiration (74 min), and 100% hyperbaric oxygen respiration at 3.0 bar (20 min)
(reproduced with permission from the American Thoracic Society)

TABLE 1

Selection of larger studies of the effects of carbon monoxide on the health of patients

First author/ year	Design	Time period	Intervention/variable	Result	N	Comment
Satran 2005 (13)	Retrospective cohort study	1994–2002	All patients with HBO, 1 course of treatment (2.4 atm)	37% of patients with CO intoxication had raised cardiac biomarkers or ECG changes, in-hospital mortality was 5%,	230	Cohort identical to Henry (14)
Henry 2006 (14)	Prospective cohort study	1994–2005	All patients with HBO, 1 course of treatment (2.4 atm)	Myocardial injury as a significant predictor for mortality in the 7.6 year observation period (AHR 2.1; 95% CI [1.2; 3.7])	230	Cohort identical to Satran (13)
Huang 2014 (17)	Longitudinal cohort study	1999–2010	Patients with CO intoxication versus control group	Increased long-term mortality (12 month follow-up period) after CO intoxication (8.39% versus 1.61% in control cohort)	441	Control cohort n = 8 820
Lee 2015 (16)	Population-based cohort study	2000–2011	Observational study, all patients with CO intoxication	Increased risk for cardiac arrhythmias (AHR 1.83; 95% CI [1.43; 2.33])	8 381	Control cohort n = 33 524
Kaya 2016 (18)	Prospective cohort study	2005–2007	Patients with CO intoxication, COHb at admission	10% of all patients with CO poisoning had a myocardial infarction during the follow-up period of 56 months on average; COHb concentrations >45% are a predictive parameter (with 98% sensitivity and 94.1% specificity) for developing myocardial infarction	1 013	No control group
Wong 2016 (11)	Population-based cohort study	2005–2010	Observational study, all patients with CO intoxication	CO intoxication: increased risk for dementia (AHR 2.75; 95% CI [2.26; 3.35])	14 590	Control cohort n = 58 360
Wong 2017 (15)	Population-based cohort study	2005–2010	Observational study, all patients with CO intoxication	CO intoxication: increased risk for cardiovascular events (AHR 2.0; 95% CI [1.83; 2.18])	13 939	Control cohort n = 55 756
Huang 2017 (19)	Population-based cohort study	1999–2012	Observational study, all patients with CO intoxication	CO intoxication: increased risk for diabetes mellitus (AHR 1.92; 95% CI [1.79; 2.06])	22 308	Control cohort n = 66 924

AHR, adjusted hazard ratio; atm, physical atmospheric pressure [standard atmosphere] (bar); 95% CI, 95% confidence interval; CO, carbon monoxide; COHb, carboxyhemoglobin; ECG, electrocardiogram; HBO, hyperbaric oxygen therapy

TABLE 2

Contents and levels of evidence of identified recommendations and guidelines

First author (year) title	Publication type	Recommendation	Reported methodological quality	Reported recommen- dation grade	Level of evidence (LoE ^{*1})
Buckley (2011): Hyperbaric oxygen for carbon monoxide poisoning (21)	Systematic review (Cochrane review)	– 100% oxygen or HBOT; no recommendation of routine HBOT if proof of superiority is lacking	Systematic search and review, structured consensus finding	Very low (according to GRADE quality of evidence ^{*2})	1a
Mintegi (2013): Pediatric cyanide poisoning by fire smoke inhalation (22)	Recommended course of action from an expert group	– 100% oxygen	Consensus finding (informal approach)	(–)	(–)
Truhlář (2015): Circulatory arrest in specific situations (23)	Evidence and consensus based guideline from a representative committee	– 100% oxygen – HBOT in pregnancy or cardiac ischemia	Systematic search and review, structured consensus finding	High	2b
Wolf (2017): Clinical policy: critical issues in the evaluation and management of [...] with acute carbon monoxide poisoning (20)	Evidence and consensus based guideline from a representative committee	– NBOT or HBOT (no recommendation) – Diagnostic evaluation: ECG and cardiac enzymes, no routine use of non-invasive COHb measurements	Systematic search and review, structured consensus finding	Moderate	2b
Mathieu (2017): [...] recommendations for accepted and non-accepted clinical indications and practice of hyperbaric oxygen treatment (24)	Evidence and consensus based guideline from a representative committee	– 100% oxygen – HBOT within up to 24 hours after exposure	Systematic search and review, structured consensus finding	High	(2–3)

^{*1} Evidence review according to the Levels of Evidence (LoE) of the Oxford Centre for Evidence-Based Medicine of 2009 (e26)

^{*2} GRADE (Grading of Recommendations Assessment, Development and Evaluation) quality of evidence:

High Further research is very unlikely to change our confidence in the estimate of effect.

Moderate Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate.

Low Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.

Very low Any estimate of effect is very uncertain.

COHb, carboxyhemoglobin; ECG, electrocardiogram; HBOT, hyperbaric oxygen therapy; NBOT, normobaric oxygen therapy

TABLE 3

Existing evidence for therapy using hyperbaric oxygen versus normobaric oxygen

First author/ year	Design	Intervention/ variable	Primary endpoint	Result	N	Benefit advan- tage for HBO	Comment
Chang 2016 (33)	Retrospective cohort study	Children with HBO vs NBO	Neurological late sequelae	No benefit of HBO	81	No	n = 21 HBO, n = 60 NBO, precise treatment modalities not known
Huang 2017 (34)	Retrospective cohort study	HBO vs no HBO	Neurological sequelae, fatality	Lower mortality with HBO especially in patients with <20 years of life and patients with pulmonary failure (4 years of follow-up); no reduction in neurological late sequelae for HBO; more frequent treatment (>2 courses) is better than one course	25 737	Yes	n = 7 278 HBO therapy, n = 18 459 no HBO, precise treat- ment modalities not known
Rose 2018 (35)	Retrospective analysis	HBO vs no HBO	Fatality; fatality at 1 year	Reduced acute fatality and fatality at 1 year with HBO	1 099	Yes	n = 285 HBO, n = 811 no HBO, precise treatment modalities not known

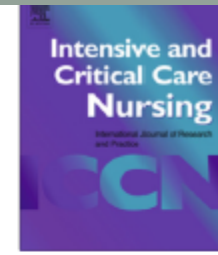
atm, physical atmospheric pressure [standard atmosphere] (bar); CO, carbon monoxide; COHb, carboxyhemoglobin; EEG, electroencephalogram; HBO, hyperbaric oxygen therapy; NBO, normobaric oxygen therapy

Case Report

Hyperbaric oxygen for late sequelae of carbon monoxide poisoning enhances neurological recovery: case report

Lon W Keim, MD ¹; Sreekanth Koneru, MD ²; Vesper Fe Marie Ramos, MD ²; Najib Murr, MD ²,
Deborah S. Hoffnung, PhD ³; Daniel L. Murman, MD ²; Jeffrey S. Cooper, MD ¹;
Diego Torres-Russotto, MD ²

- Ağır CO zehirlenmesinden 2 ay sonra korea ve distoni, 90 gün sonra da parkinsonizm bulguları gösteren vakada 20 seans HBO tedavisi sonrası klinik belirgin olarak düzelmiş. UPDRS ölçeği 40'tan 10'a gerilemiş.



Case Study

Carbon monoxide poisoning in a young, healthy patient: A case study of heart failure recovery after Hyperbaric Oxygenation Treatment



Michael Kuniavsky ^{a,b,d,e,*}, Yair Bechor ^a, Marina Leitman ^c, Shai Efrati ^a

^aThe Sagol Center for Hyperbaric Medicine and Research, Assaf haRofeh Medical Center, Beer-Jaacov 70300, Israel

^bGeneral ICU, Assaf haRofeh Medical Center, Beer-Jaacov 70300, Israel

^cCardiology Department, Assaf haRofeh Medical Center, Beer-Jaacov 70300, Israel

^dMinistry of Health, Yermiyahy 39 street, Jerusalem, POB 9101002, Israel

^eThe Hebrew University-Hadassah Braun School of Public Health and Community medicine, Jerusalem, Israel

- CO intoksikasyonu sonrası akut dönemde entübe halde 24 saat içerisinde her seferinde 120 dakika süreyle 3 seans HBO tedavisi yapılan ve EF %30'dan normal fonksiyonlara gelen total hipokinezisi iyileşen vaka.

Ambient carbon monoxide and cardiovascular mortality: a nationwide time-series analysis in 272 cities in China

Cong Liu, Peng Yin,* Renjie Chen,* Xia Meng, Lijun Wang, Yue Niu, Zhijing Lin, Yunning Liu, Jiangmei Liu, Jinlei Qi, Jinling You, Haidong Kan, Maigeng Zhou*

- Ocak 2013-Aralık 2015 arasındaki 272 şehirdeki hastalık izlem noktalarından ve ulusal gerçek zamanlı hava kalitesi yayın platformundan elde edilen verilerle yapılan bir çalışma.
- Ortalama karbonmonoksit değerinin $1\text{--}20\text{ mg/m}^3$ ölçüldüğü çalışmada karbonmonoksit değerinin 1 mg/m^3 üzerine çıktığı günlerde bir önceki güne göre kardiyovasküler hastalıklardan ölüm oranını %1.12 arttığı, koroner kalp hastalığından ölüm oranını %1.75 arttığı, inmelerde de %0.88 artış olduğu görülmüş.



Contents lists available at [ScienceDirect](#)

NeuroToxicology



Full Length Article

Neurotoxicity of carbon monoxide targets caudate-mediated dopaminergic system



Tzu-Kuan Sun^{a,1}, Yen-Yu Chen^{b,1}, Shu-Hua Huang^c, Shih-Wei Hsu^d, Chen-Chang Lee^d, Wen-Neng Chang^a, Chi-Wei Huang^a, Chun-Chung Lui^e, Chia-Yi Lien^a, Ju-Ling Cheng^c, Chiung-Chih Chang^{a,*}

^a Department of Neurology, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Kaohsiung, Taiwan

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^c Department of Nuclear Medicine, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Kaohsiung, Taiwan

^d Department of Radiology, Kaohsiung Chang Gung Memorial Hospital, Chang Gung University College of Medicine, Kaohsiung, Taiwan

^e Division of medical imaging, E-Da Cancer Hospital and I-Shou University, Kaohsiung, Taiwan

- Presinaptik düzeyde nöronal dopamin azalmasının görüntülemesinde kullanılan 99mTcTRODAT-1 ile yapılan bu çalışmaya CO intoksikasyonlu 29 parkinsonizm bulguları olan, 35 parkinsonizm bulguları olmayan hasta dahil edilmiş.

- Unified Parkinson's Disease Rating Scale (UPDRS)-part III motor skorumlama sistemi hastaların parkinson ciddiyetini skorumlamada, psikiyatrik durumlarını ölçmede de kapsamlı nöro-davranışsal testler kullanılmış.
- Parkinsonizm gösteren grupta nöropsikiyatrik skorlar ve bilişsel skorlar düşük gelmekle birlikte 99mTcTRODAT-1 ile kaudat nükleuslarda sinyal azalması gözlenmiş. Ayrıca nörodavranışsal testler ile UPDRS skorları da yüksek düzeyde korele bulunmuş.

Clinical Outcomes and Mortality Impact of Hyperbaric Oxygen Therapy in Patients With Carbon Monoxide Poisoning

Jason J. Rose, MD, MBA^{1,2}; Mehdi Nouraie, MD, PhD^{1,2}; Marc C. Gauthier, MD²;
Anthony F. Pizon, MD^{3,4}; Melissa I. Saul, MS⁵; Michael P. Donahoe, MD^{2,5}; Mark T. Gladwin, MD^{1,5}

- ABD'de retrospektif bir çalışmaya göre hiperbarik oksijen tedavisi ile yatan hastalardaki mortalitede %2.1 azalma, 1 yıllık mortalitede ise benzer şekilde %2.1 azalmaya neden olmuştur.(n=1099)

ECMO improves survival following cardiogenic shock due to carbon monoxide poisoning - an experimental porcine model

Carsten Simonsen^{1,2*} , Sigridur O. Magnúsdóttir^{2,3}, Jan J. Andreasen^{1,2}, Marianne Cathrine Rohde⁴ and Benedict Kjærgaard^{1,2,3}

- ECMO gruptaki tüm hayvanlar kurtarılmış. Sadece birisinde kardiyak arrest gelişmiş.
- Ventilatör grubunda ise sadece bir hayvan yaşamış 5'i arrest olmuş. Arrest olan 5 hayvandan 4 ü ECMO'ya bağlanmış ve 4 ü yaşamış.

Serum neuron-specific enolase as an early predictor of delayed neuropsychiatric sequelae in patients with acute carbon monoxide poisoning

**YS Cha¹, H Kim¹, HH Do², HI Kim¹, OH Kim¹, K-C Cha¹,
KH Lee¹ and SO Hwang¹**

- 9 ay boyunca takip edilen nörolojik sekelli hastalarda yapılan retrospektif çalışma. Acile başvuru anında bu hastaların serum NSE, Troponin I düzeyleri ve GCS skorlarında anlamlı farklılık var.

Table 1. Baseline characteristics and laboratory findings of patients with acute carbon monoxide poisoning.

	Total (<i>n</i> = 98)	Non-DNS group (<i>n</i> = 90, 91.8%)	DNS group (<i>n</i> = 8, 8.2%)	<i>p</i> -Value
NSE (ng/mL)	21.5 (17.0–29.5) ^a	21.5 (16.0–27.3) ^a	45.6 (23.1–53.9) ^a	0.002
Creatinine kinase (U/L)	132 (88–399) ^a	124 (86–269) ^a	740 (189–4091) ^a	0.005
Troponin I (ng/mL)	0.015 (0.015–0.339) ^a	0.015 (0.015–0.100) ^a	0.948 (0.513–1.748) ^a	<0.001
GCS	15 (13–15) ^a	15 (14–15) ^a	9 (7–11) ^a	<0.001

Mapping of carbon monoxide related death risk in Turkey: a ten-year analysis based on news agency records

Günay Can¹, Uğurcan Sayılı^{1*} , Özden Aksu Sayman¹, Ömer Faruk Kuyumcu², Duygu Yılmaz², Eren Esen¹, Eray Yurtseven¹ and Ethem Erginöz¹

- Türkiye’de medya taramalı 10 yıllık bir çalışma. 2667 CO zehirlenmesi ilişkili ölüm vakaları dahil edilmiş.
- Ölümler 50 yaş üzerinde oldukça fazla.
- Gaziantep, İstanbul, Ankara, Konya ve Bursa en sık ölüm gelişen illerimiz.
- Nüfusa oranlanınca en yüksek oranlı iller sırasıyla Kilis, Kırıkkale, Karabük, Niğde, Kayseri

TEŞEKKÜRLER