PHYSICIAN REFERRAL GUIDE

CANADA HYPERBARICS

Hyperbaric Oxygen for Carbon Monoxide Poisoning

A referral guide for emergency and referring physicians in Canada.

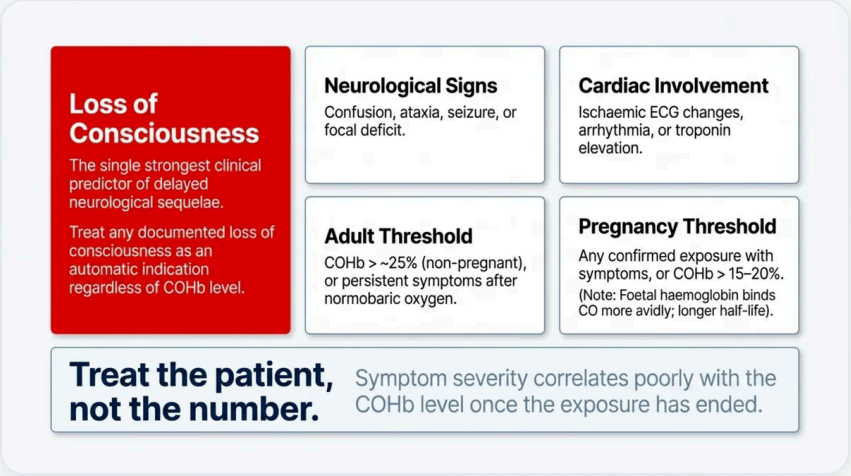
Condition: **Carbon Monoxide Poisoning** Open-access studies: **95** Updated **June 2026** Reviewed **quarterly**

For referring and emergency physicians in Canada. Carbon monoxide poisoning is one of the 14 conditions Health Canada recognises for hyperbaric oxygen therapy (HBOT), and it is treated as an emergency at every Canadian hospital-based hyperbaric programme, fully covered by provincial health insurance. This guide summarises when to refer, how to assess the patient before referral, what the evidence supports, the Canadian referral pathway, and contraindications. It closes with the complete list of open-access research published since 2020, each linked to its free full text.

IN THIS GUIDE

When to refer

Refer urgently for hyperbaric assessment when a patient with confirmed or strongly suspected acute carbon monoxide exposure has any of the following:



FIGURE

When to refer: loss of consciousness is the single strongest predictor of delayed sequelae. Treat the patient, not the number, because symptom severity correlates poorly with the carboxyhaemoglobin level once exposure has ended.

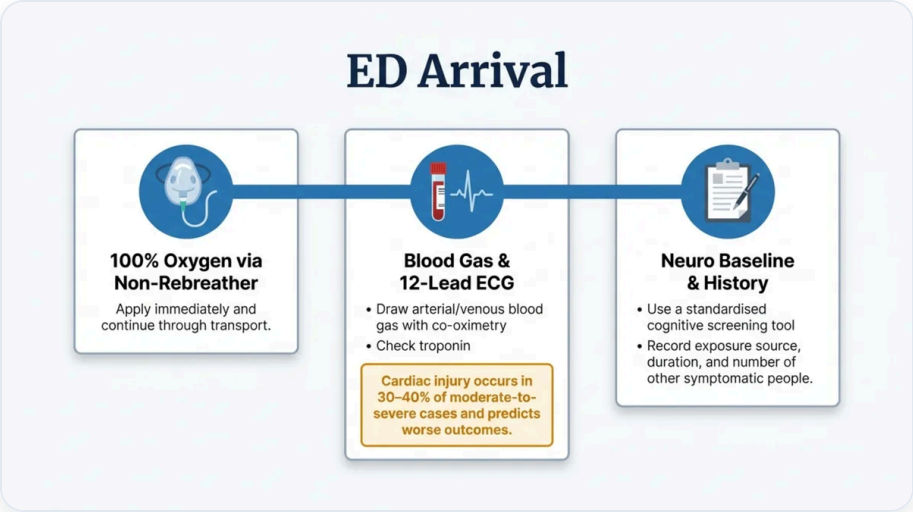
- **Loss of consciousness** during or after exposure, even briefly. This is the single strongest clinical predictor of delayed neurological sequelae, and many Canadian programmes treat any documented loss of consciousness as an automatic indication regardless of the measured carboxyhaemoglobin (COHb) level.
- **Neurological signs** such as confusion, ataxia, seizure, or focal deficit.
- **Cardiac involvement** such as ischaemic ECG changes, arrhythmia, or troponin elevation.

- **COHb above roughly 25 percent** in a non-pregnant adult, or persistent symptoms after initial normobaric oxygen.
- **Pregnancy** with any confirmed exposure and symptoms, or COHb above 15 to 20 percent. Pregnancy is a strong indication rather than a contraindication: foetal haemoglobin binds CO more avidly than adult haemoglobin and the foetal COHb half-life is several times longer than the maternal value.

Symptom severity correlates poorly with the COHb level once the exposure has ended, because COHb is already falling by the time the patient reaches hospital. Treat the patient, not the number.

Assessing the patient before referral

While arranging hyperbaric assessment, the receiving emergency department should:



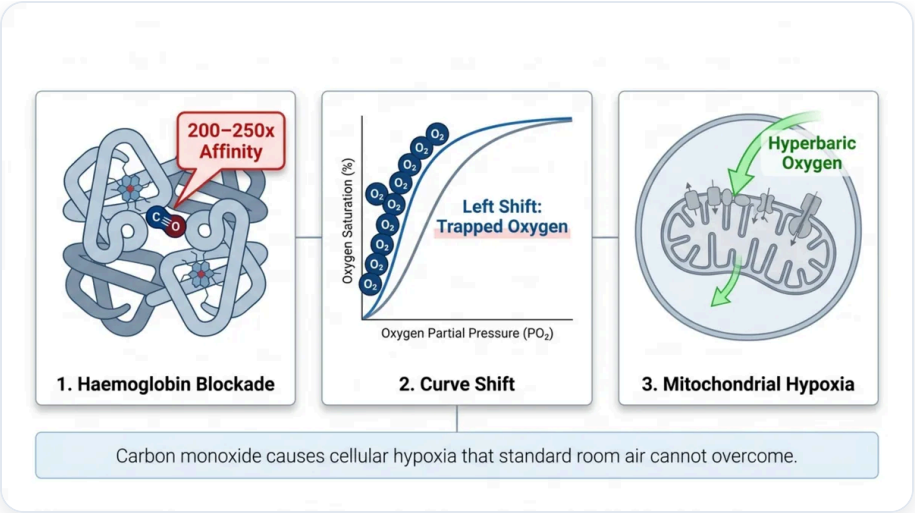
FIGURE

Before referral: 100 percent oxygen by non-rebreather mask, a blood gas with co-oximetry, a 12-lead ECG and troponin, and a documented neurological baseline. Cardiac injury occurs in 30 to 40 percent of moderate-to-severe cases.

- Place the patient on **100 percent oxygen by non-rebreather mask** immediately and continue it through transport.
- Draw an arterial or venous **blood gas with co-oximetry** to confirm the COHb level.
- Obtain a **12-lead ECG and troponin**. Cardiac injury occurs in roughly 30 to 40 percent of moderate-to-severe cases and predicts worse outcomes.
- Document a **baseline neurological and cognitive status** with a standardised screening tool, so later delayed-sequelae assessment has a reference point.
- Record the **exposure history**: source, duration, loss of consciousness, and the number of other symptomatic people from the same environment.

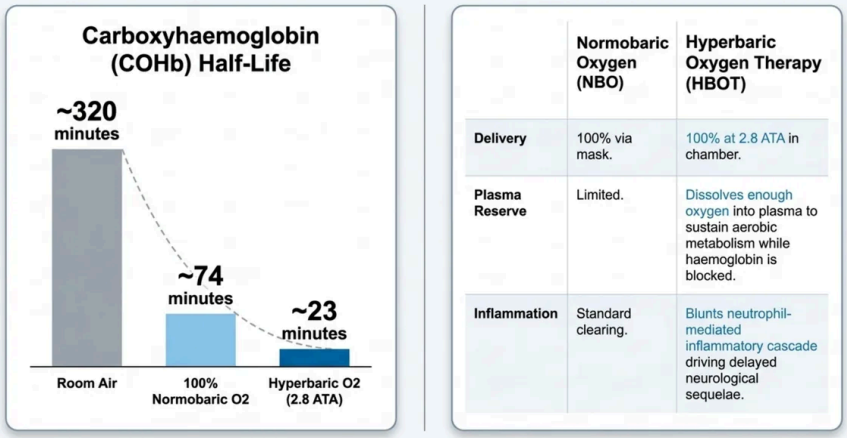
What the evidence supports

The reference evidence is the **Weaver et al. randomised controlled trial (NEJM 2002, 152 patients)**, which found cognitive sequelae at six weeks in 25 percent of hyperbaric-treated patients versus 46 percent of those receiving normobaric oxygen, with the benefit persisting at twelve months. This trial established hyperbaric oxygen as the standard of care for moderate-to-severe poisoning and remains the most-cited evidence in Canadian practice.



FIGURE

How carbon monoxide causes cellular hypoxia: haemoglobin blockade, a left shift that traps oxygen, and mitochondrial hypoxia that room air alone cannot overcome.



	Normobaric Oxygen (NBO)	Hyperbaric Oxygen Therapy (HBOT)
Delivery	100% via mask.	100% at 2.8 ATA in chamber.
Plasma Reserve	Limited.	Dissolves enough oxygen into plasma to sustain aerobic metabolism while haemoglobin is blocked.
Inflammation	Standard clearing.	Blunts neutrophil-mediated inflammatory cascade driving delayed neurological sequelae.

FIGURE

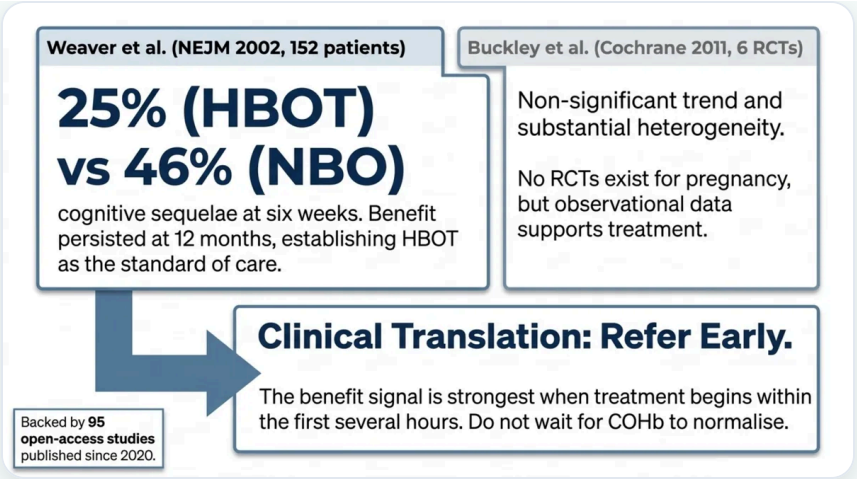
Carboxyhaemoglobin half-life falls from about 320 minutes on room air to about 74 minutes on normobaric oxygen and about 23 minutes at 2.8 ATA. Hyperbaric oxygen also adds a dissolved-plasma oxygen reserve and blunts the inflammatory cascade.

The mechanistic rationale is well established. COHb half-life falls from about 320 minutes on room air to about 74 minutes on 100 percent normobaric oxygen and to about 23 minutes at 2.8 ATA in the chamber. Beyond faster elimination, hyperbaric oxygen dissolves enough oxygen into plasma to sustain aerobic metabolism while haemoglobin is blocked, and it blunts the neutrophil-mediated inflammatory cascade that drives delayed neurological sequelae.

The evidence is not uniform. A **Cochrane review (Buckley et al. 2011, 6 RCTs)** found only a non-significant trend toward reduced delayed sequelae and noted substantial heterogeneity across trials. The most consistent positive signal is early treatment using the Weaver protocol. In pregnancy, no randomised trials exist, but case series and observational data support treatment for any confirmed exposure with symptoms.

◈ Clinical translation

Refer early. The benefit signal is strongest when hyperbaric treatment begins within the first several hours, so the decision to refer should not wait for a falling COHb level to normalise or for delayed symptoms to appear. When in doubt, especially with any loss of consciousness, pregnancy, or cardiac involvement, call the hyperbaric team.

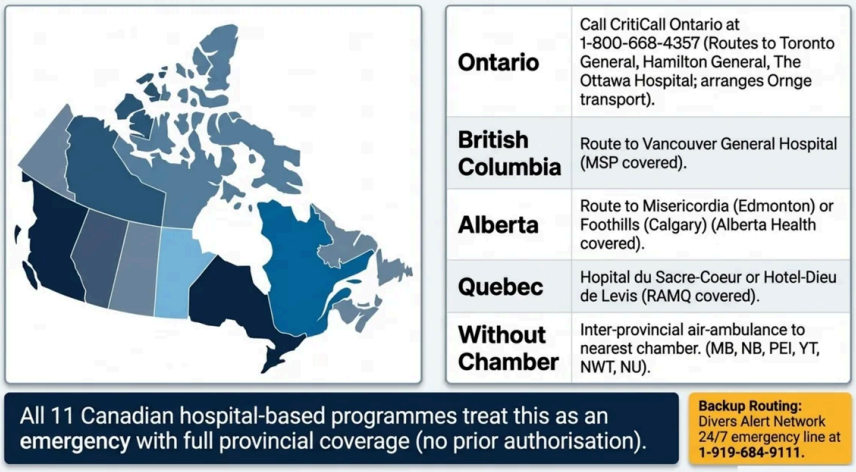


FIGURE

The Weaver trial found cognitive sequelae in 25 percent of hyperbaric-treated patients versus 46 percent on normobaric oxygen; the Cochrane review found a non-significant trend. The benefit signal is strongest when treatment begins early.

The Canadian referral pathway

Carbon monoxide poisoning is treated as an emergency at all 11 Canadian hospital-based hyperbaric programmes and is covered by every provincial plan without prior authorisation.



FIGURE

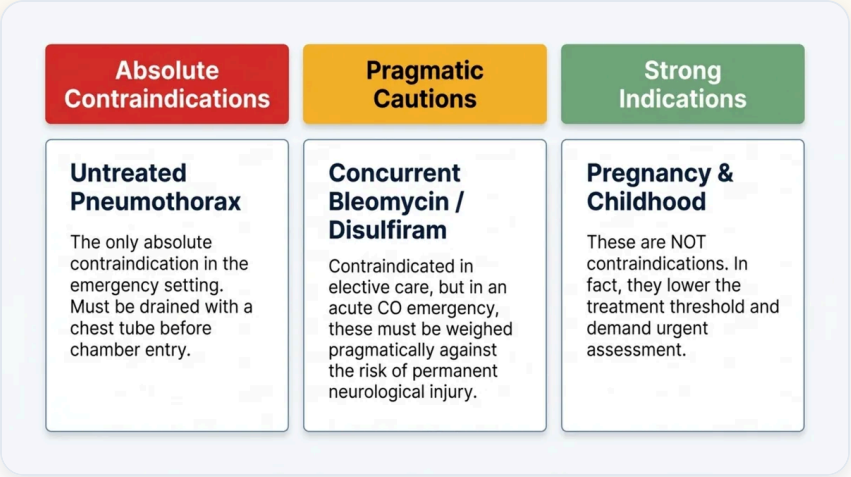
The Canadian referral pathway by province. All eleven hospital-based programmes treat carbon monoxide poisoning as an emergency with full provincial coverage and no prior authorisation.

- **Ontario:** call **CritiCall Ontario at 1-800-668-4357**, the single coordination line that connects emergency departments to the Toronto General (UHN), Hamilton General, and The Ottawa Hospital programmes and arranges Ornge transport when needed.
- **British Columbia:** route to Vancouver General Hospital (Leon Judah Blackmore Pavilion), the only hospital chamber in the province; covered under MSP.
- **Alberta:** route to Misericordia Community Hospital (Edmonton) or Foothills Medical Centre / Arthur J.E. Child Comprehensive Cancer Centre (Calgary); covered by Alberta Health.
- **Quebec:** RAMQ covers Hopital du Sacre-Coeur de Montreal and Hotel-Dieu de Levis.
- **Provinces and territories without a chamber** (Manitoba, New Brunswick, PEI, Yukon, NWT, Nunavut): inter-provincial air-ambulance referral to the nearest chamber, most commonly Misericordia Edmonton or the Ontario programmes.

The **Divers Alert Network 24/7 emergency line at 1-919-684-9111** can also help Canadian emergency departments locate the nearest accepting chamber when local pathways fail.

Contraindications and cautions

The only absolute contraindication relevant in the emergency setting is an **untreated pneumothorax**, which must be drained with a chest tube before chamber entry. **Concurrent bleomycin** and **concurrent disulfiram** are contraindications in elective hyperbaric care; in an acute CO emergency they are weighed pragmatically against the risk of permanent neurological injury. Pregnancy and childhood are not contraindications and in fact lower the treatment threshold.



FIGURE

Untreated pneumothorax is the only absolute contraindication in the emergency setting. Concurrent bleomycin or disulfiram are weighed pragmatically; pregnancy and childhood lower the treatment threshold rather than raising it.

How to use the research list below

The list contains every carbon monoxide poisoning study in the Canada Hyperbarics database that was published in 2020 or later **and** has a freely available full-text version, each linked directly to that full text. Paywalled and abstract-only studies are excluded, and retracted studies are removed. This is a reference list, not a set of summaries. Counts and the open-access set refresh each quarter.

Open-access research, 2020 to present

95 studies with a free full-text version, grouped by year, newest first. Each title links to the full text. Retracted and paywalled studies are excluded; the set refreshes quarterly.

2026

1. Jia Y et al.. Predictive value of acute MRI-detected brain lesions for clinical outcome in patients with acute carbon monoxide poisoning. *Eur J Med Res.*
2. Thanasitthichai S et al.. Investigation of the first carbon monoxide poisoning cluster associated with a hotpot restaurant in Thailand, 2023. *Western Pac Surveill Response J.*
3. Ishiguro Y et al.. Hippocampi and midbrain lesions in carbon monoxide intoxication: a rare case report. *BMC Neurol.*
4. Lee H et al.. Agreement and clinical utility of non-invasive SpCO versus arterial COHb in acute carbon monoxide poisoning: a prospective observational study. *Sci Rep.*
5. Fujita M et al.. Evaluating the Efficacy of Hyperbaric Oxygen Therapy for Acute Carbon Monoxide Poisoning: A Systematic Review and Meta-Analysis. *Acute Med Surg.*
6. Yang L et al.. Hyperbaric oxygen for paroxysmal sympathetic hyperactivity syndrome after acute carbon monoxide poisoning. *Med Gas Res.*
7. Gong H et al.. Study on the construction of a predictive model for delayed encephalopathy after acute carbon monoxide poisoning. *BMC Neurol.*

2025

1. Aykut A et al.. Serum lactate and carboxyhemoglobin as predictors of hyperbaric oxygen therapy in carbon monoxide poisoning: a retrospective study. *BMC Emerg Med.*

2. Dent MR et al.. Engineering a highly selective, hemoprotein-based scavenger as a carbon monoxide poisoning antidote with no hypertensive effect. *Proceedings of the National Academy of Sciences of the United States of America*.
3. Tuo L et al.. Hyperkalemia combined with carbon monoxide poisoning, should hemodialysis or hyperbaric oxygen treatment be given first?: A CARE-compliant article. *Medicine (Baltimore)*.
4. Cao L et al.. Exploring medical gas therapy in hemorrhagic stroke treatment: A narrative review. *Nitric oxide : biology and chemistry*.
5. Yılmaz A et al.. Retrospective analysis of carbon monoxide exposure cases in a secondary-level state hospital emergency department. *Ann Saudi Med*.
6. Khelifa S et al.. Acute Carbon Monoxide Poisoning in the Emergency Department: A Descriptive Study of 660 Cases in Tunisia. *La Tunisie medicale*.
7. Zhang J et al.. The inflammatory markers MHR and NLR are independent risk factors for adverse events during hospitalization in older adult patients with myocardial injury caused by acute carbon monoxide poisoning: a retrospective cross-sectional study. *Medical gas research*.
8. Afzal M et al.. Carbon Monoxide Poisoning: Diagnosis, Prognostic Factors, Treatment Strategies, and Future Perspectives. *Diagnostics (Basel)*.
9. Kim Y et al.. Fatality Rate in Hospitalized Patients Due to Carbon Monoxide Poisoning in the Democratic People's Republic of Korea. *J Korean Med Sci*.
10. Lee J et al.. Risk Factors for Middle Ear Barotrauma in Patients with Carbon Monoxide Poisoning Undergoing Monoplace Hyperbaric Oxygen Therapy: A Retrospective Cohort Study. *J Clin Med*.
11. Jia Y et al.. Hyperbaric oxygen therapy for acute carbon monoxide poisoning patients with coma onset. *Eur J Med Res*.
12. Hwang H et al.. Carbon monoxide poisoning is associated with increased risk of migraine in the long term: a nationwide population-based cohort study. *Front Toxicol*.
13. Ho MP et al.. Potential risk factors for delayed neurological sequelae and myocardial injury following acute carbon monoxide poisoning: A retrospective study. *Journal of the Chinese Medical Association : JCMA*.
14. Zhao W et al.. Incidence and independent risk factors of lower extremity deep vein thrombosis in patients with acute carbon monoxide poisoning: a retrospective study. *Am J Transl Res*.
15. Lin Z et al.. Brachial radiculopathy with intact central nervous system imaging following carbon monoxide poisoning: A case report. *Clin Neurophysiol Pract*.
16. Yao M et al.. HBOT-induced noncardiogenic pulmonary edema in acute carbon monoxide poisoning: A case report and mechanistic insights. *Medicine (Baltimore)*.
17. Shin S et al.. Effect of hyperbaric oxygen therapy on early features of carbon monoxide poisoning focusing on neurological symptoms. *International journal of emergency medicine*.
18. Kurokawa T et al.. Rapid Initiation of Hyperbaric Oxygen Therapy for Multiple Simultaneous Cases of Acute Carbon Monoxide Poisoning at a Single Center. *Mil Med*.

2024

1. Taghdiri A. Cardiovascular biomarkers: exploring troponin and BNP applications in conditions related to carbon monoxide exposure. *The Egyptian heart journal : (EHJ) : official bulletin of the Egyptian Society of Cardiology*.
2. Liu Z et al.. Analysis of factors associated with the development of delayed encephalopathy following acute carbon monoxide poisoning. *Sci Rep*.
3. Freitas C et al.. Hyperbaric Medicine in Pediatrics - reality of a Portuguese reference center. *Rev Paul Pediatr*.
4. Vural A et al.. Early and late adverse clinical outcomes of severe carbon monoxide intoxication: A cross-sectional retrospective study. *PLoS One*.
5. Wong ZK et al.. Hyperbaric oxygen for the treatment of carbon monoxide-induced delayed neurological sequelae: a case report and review of the literature. *Diving and hyperbaric medicine*.
6. Chen L et al.. The new insights of hyperbaric oxygen therapy: focus on inflammatory bowel disease. *Precision clinical medicine*.
7. Jingami N et al.. Case report: Consecutive hyperbaric oxygen therapy for delayed post-hypoxic leukoencephalopathy resulting from CHANTER syndrome caused by opioid intoxication. *Front Med (Lausanne)*.
8. Ozgok Kangal K et al.. Hyperbaric oxygen treatment for infants: retrospective analysis of 54 patients treated in two tertiary care centres. *Diving and hyperbaric medicine*.
9. Popiolek C et al.. Mass Carbon Monoxide Poisoning at a Daycare: A Public Health Lesson. *Cureus*.
10. Baksevice D et al.. Carbon monoxide poisoning: a clinical case report. *Int J Emerg Med*.
11. Koyuncu S et al.. Carbon Monoxide Intoxication Leading to Crush Syndrome and Acute Renal Failure: A Case Report. *Cureus*.
12. Mo J et al.. A woman with carotid atherosclerotic plaques suffered a massive cerebral infarction after carbon monoxide poisoning-A case report. *Heliyon*.
13. Bastelica P et al.. Hyperbaric oxygen therapy and eye disease: Review of the literature. *Journal francais d'ophtalmologie*.
14. Liu S et al.. Isolated unilateral brachial plexus injury following carbon monoxide intoxication: a case report and literature review. *Frontiers in neurology*.
15. Shen G et al.. Positive 14-3-3 protein in cerebrospinal fluid followed by poppy-induced delayed post-hypoxic leukoencephalopathy: A case report. *Heliyon*.
16. Li W et al.. Carbon monoxide poisoning with hippocampi lesions on MRI: cases report and literature review. *BMC neurology*.

2023

1. Camacho C et al.. From Carbon Monoxide Poisoning to Myocardial Infarction. *Cureus*.
2. Yoo KH et al.. Predicting acute brain lesions on magnetic resonance imaging in acute carbon monoxide poisoning: a multicenter prospective observational study. *Scientific reports*.

3. Han E et al.. Prevalence of Carbon Monoxide Poisoning and Hyperbaric Oxygen Therapy in Korea: Analysis of National Claims Data in 2010-2019. *Journal of Korean medical science*.
4. İpek S et al.. The effect of full blood count and cardiac biomarkers on prognosis in carbon monoxide poisoning in children. *Irish journal of medical science*.
5. Cho DH et al.. Clinical and Echocardiographic Predictors for the Presence of Late Gadolinium Enhancement on Cardiac Magnetic Resonance Imaging in Patients with Carbon Monoxide Poisoning. *Diagnostics (Basel, Switzerland)*.
6. Aydin F. Hyperbaric oxygen treatment in children: experience in 329 patients. *Diving and hyperbaric medicine*.
7. Sethuraman K et al.. Hyperbaric oxygen should be used for carbon monoxide poisoning. *British journal of clinical pharmacology*.
8. Mohsen G et al.. Carbon monoxide intoxication with a CO-Hb of 30% while smoking waterpipe: a case report. *Int J Emerg Med*.
9. Endo T et al.. Sensorineural Hearing Loss due to Acute Carbon Monoxide Poisoning. *The journal of international advanced otology*.
10. Hagiwara K et al.. Delayed neuropsychiatric sequelae with improvement of decreased cerebral bold flow by single-photon emission computed tomography during hyperbaric oxygen therapy: A case report with a 10-year follow-up. *PCN Rep*.
11. Yanagawa Y et al.. Narrative minireview of the current status of hyperbaric oxygen therapy for pregnant women. *Acute medicine & surgery*.
12. Uysalol M et al.. How to Decide Oxygen Therapy in Childhood Carbon Monoxide Poisoning?. *Turkish archives of pediatrics*.
13. Steenebruggen F et al.. Hyperbaric oxygenation improve red blood cell deformability in patients with acute or chronic inflammation. *Microvascular research*.
14. Bagares L et al.. Acute Carbon Monoxide Poisoning in a Filipino Household: A Case Report. *Cureus*.
15. Lee K et al.. Systemic Venous Air Emboli After Emergent Hyperbaric Therapy for Carbon Monoxide Poisoning. *Am J Case Rep*.
16. Turgut B et al.. Hemiplegia resulting from acute carbon monoxide poisoning. *Diving and hyperbaric medicine*.

2022

1. Chiang M et al.. Validation of Diagnostic Codes to Identify Carbon Monoxide Poisoning in Taiwan's Claims Data. *Front Pharmacol*.
2. Ma S et al.. Carbon monoxide poisoning-induced encephalopathy in a carbon dioxide arc welder: a case report. *Ann Occup Environ Med*.
3. Zhang C et al.. Hyperbaric oxygen treatment improves pancreatic β-cell function and hepatic gluconeogenesis in STZ-induced type-2 diabetes mellitus model mice. *Molecular medicine reports*.
4. Fischbach A et al.. Veno-venous extracorporeal blood phototherapy increases the rate of carbon monoxide (CO) elimination in CO-poisoned pigs. *Lasers in surgery and medicine*.
5. Wang K et al.. Therapeutic study of hyperbaric oxygen on heme oxygenase-1 (HO-1) in patients with acute carbon monoxide poisoning and myocardial injury. *Cell Mol Biol (Noisy-le-grand)*.
6. Kreshak AA et al.. Perinatal Carbon Monoxide Poisoning: Treatment of a 2-Hour-Old Neonate with Hyperbaric Oxygen. *AJP reports*.
7. Wang YM et al.. Exercise-induced myocardial ischemia presenting as exercise intolerance after carbon monoxide intoxication and smoke inhalation Injury: case report. *BMC cardiovascular disorders*.
8. Ho Y et al.. Should We Use Hyperbaric Oxygen for Carbon Monoxide Poisoning Management? A Network Meta-Analysis of Randomized Controlled Trials. *Healthcare (Basel)*.
9. Simman R et al.. Role of Hyperbaric Oxygen Therapy in Cosmetic and Reconstructive Surgery in Ischemic Soft Tissue Wounds: A Case Series. *Eplasty*.
10. Huang F et al.. Prognostic factors of hyperbaric oxygen therapy for patients with delayed encephalopathy after acute carbon monoxide poisoning. *Heliyon*.
11. Krakowiak M et al.. YouTube as a source of information on carbon monoxide poisoning: a content-quality analysis. *Int J Occup Med Environ Health*.

2021

1. Kosaki Y et al.. Carbon monoxide poisoning during pregnancy treated with hyperbaric oxygen. *Clinical case reports*.
2. Tetsuka S et al.. Repeated unconsciousness due to chronic carbon monoxide poisoning in an older patient: a case report. *J Rural Med*.
3. Tamura T et al.. Memory Impairment and Hippocampal Volume after Carbon Monoxide Poisoning. *Archives of clinical neuropsychology : the official journal of the National Academy of Neuropsychologists*.
4. De Wolde SD et al.. The Effects of Hyperbaric Oxygenation on Oxidative Stress, Inflammation and Angiogenesis. *Biomolecules*.
5. Wei KY et al.. Carbon Monoxide Poisoning and Chronic Kidney Disease Risk: A Nationwide, Population-Based Study. *American journal of nephrology*.
6. Cao H et al.. The Effect of Adding Transcranial Direct Current Stimulation to Hyperbaric Oxygen Therapy in Patients With Delayed Encephalopathy After Carbon Monoxide Poisoning: A Randomised Controlled Trial. *Frontiers in neurology*.
7. Ozgok-Kangal K. Long-term infant outcomes after hyperbaric oxygen treatment for acute carbon monoxide poisoning during pregnancy. *Diving and hyperbaric medicine*.
8. Liao S et al.. Real-world effectiveness of hyperbaric oxygen therapy for delayed neuropsychiatric sequelae after carbon monoxide poisoning. *Sci Rep*.
9. Sen S et al.. Therapeutic effects of hyperbaric oxygen: integrated review. *Medical gas research*.
10. Monji A et al.. Hyperbaric Oxygen Therapy for Carbon Monoxide-Induced Delayed Neuropsychiatric Sequelae: Case Report of Two Cases and Relevant Literature Review. *Case Rep Psychiatry*.
11. Megas IF et al.. The History of Carbon Monoxide Intoxication. *Medicina (Kaunas, Lithuania)*.
12. Nah S et al.. Effects of smoking on delayed neuropsychiatric sequelae in acute carbon monoxide poisoning: A prospective observational study. *Medicine (Baltimore)*.

13. Fujita M et al.. Use of hyperbaric oxygen therapy for preventing delayed neurological sequelae in patients with carbon monoxide poisoning: A multicenter, prospective, observational study in Japan. *PloS one*.
14. Gao Y et al.. The efficacy of Rhodiola Rosea based on DTI image Segmentation Algorithm for patients with delayed Encephalopathy caused by CO poisoning. *Pakistan journal of medical sciences*.

2020

1. Costanza A et al.. Urgent hyperbaric oxygen therapy for suicidal carbon monoxide poisoning: from a preliminary survey to a proposal for an integrated somatic-psychiatric protocol. *International journal of emergency medicine*.
2. Geng S et al.. Cardiac injury after acute carbon monoxide poisoning and its clinical treatment scheme. *Experimental and therapeutic medicine*.
3. Xu SY et al.. Wallerian degeneration of bilateral cerebral peduncles after acute carbon monoxide poisoning. *BMC neurology*.
4. Underner M et al.. Carbon monoxide poisoning in active or passive shisha smokers. *Revue des maladies respiratoires*.
5. Ershad M et al.. An Unusual Case of Carbon Monoxide Poisoning from Formic and Sulfuric Acid Mixture. *Clin Pract Cases Emerg Med*.
6. Hajhosseini B et al.. Hyperbaric Oxygen Therapy: Descriptive Review of the Technology and Current Application in Chronic Wounds. *Plastic and reconstructive surgery. Global open*.
7. Chang JS et al.. Hyperbaric Oxygen Exposure Attenuates Circulating Stress Biomarkers: A Pilot Interventional Study. *International journal of environmental research and public health*.
8. Ning K et al.. Neurocognitive sequelae after carbon monoxide poisoning and hyperbaric oxygen therapy. *Medical gas research*.
9. Baran DA et al.. Pediatric Veno-Veno Extracorporeal Membrane Oxygenation Rescue From Carbon Monoxide Poisoning. *Pediatric emergency care*.
10. Maffi L et al.. Hyperbaric Oxygen Treatment for Carbon Monoxide Poisoning in Italy: Retrospective Validation of a Data Collection Tool for the Italian Registry of Carbon Monoxide Poisonings (IRCOP). *International journal of environmental research and public health*.
11. Kim HH et al.. Stroke Incidence in Survivors of Carbon Monoxide Poisoning in South Korea: A Population-Based Longitudinal Study. *Medical science monitor : international medical journal of experimental and clinical research*.
12. Olatunde O et al.. Carbon monoxide poisoning and its effect on QTc prolongation. *J Cardiol Cases*.
13. Cardoso PC et al.. Blindness and neurological sequelae following carbon monoxide poisoning: effective treatment with hyperbaric oxygen. *Archivos argentinos de pediatria*.

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