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Title: Carbon Monoxide Poisoning: The Silent Killer of Prehospital Care
Word Count: 1,390 words (excluding title page, appendix and reference list)

Carbon Monoxide Poisoning: The Silent Killer of Prehospital Care

PICO

Carbon monoxide (CO) poisoning is frequently misdiagnosed by paramedics, thus what is the hallmark feature of this condition and why is it so commonly misinterpreted?

Research Rationale

Carbon monoxide intoxication is currently the leading cause of poisoning in industrialised countries and is often missed due to its lack of colour, smell and taste (Gozubuyuk et al., 2017). To effectively treat patients and maximise beneficial outcome, paramedics must be able to recognise and suspect carbon monoxide poising in the prehospital setting.

Search Strategy

MEDLINE, EMBASE and Google Scholar were searched using the following key words to find relevant articles; prehospital, pre-hospital, out of hospital, out-of-hospital, ambulance, emergency medical services, EMS, carbon monoxide poisoning, carbon monoxide intoxication, and carbon monoxide inhalation. The reference lists of articles retrieved from the initial search were also examined to reveal any relevant articles missed in the database search. Due to the lack of recent articles on this topic, the search was extended to articles published since 1990 and involving care in the emergency department. Results were refined to articles written in English and based on humans.

Search Results

The search strategy initially produced 621 articles. Following the elimination of duplicate reports and irrelevant articles, 25 articles met the inclusion criteria, however, further analysis exhibited that only 5 were suitable for appraisal. Figure 1 outlines the process of selecting articles.

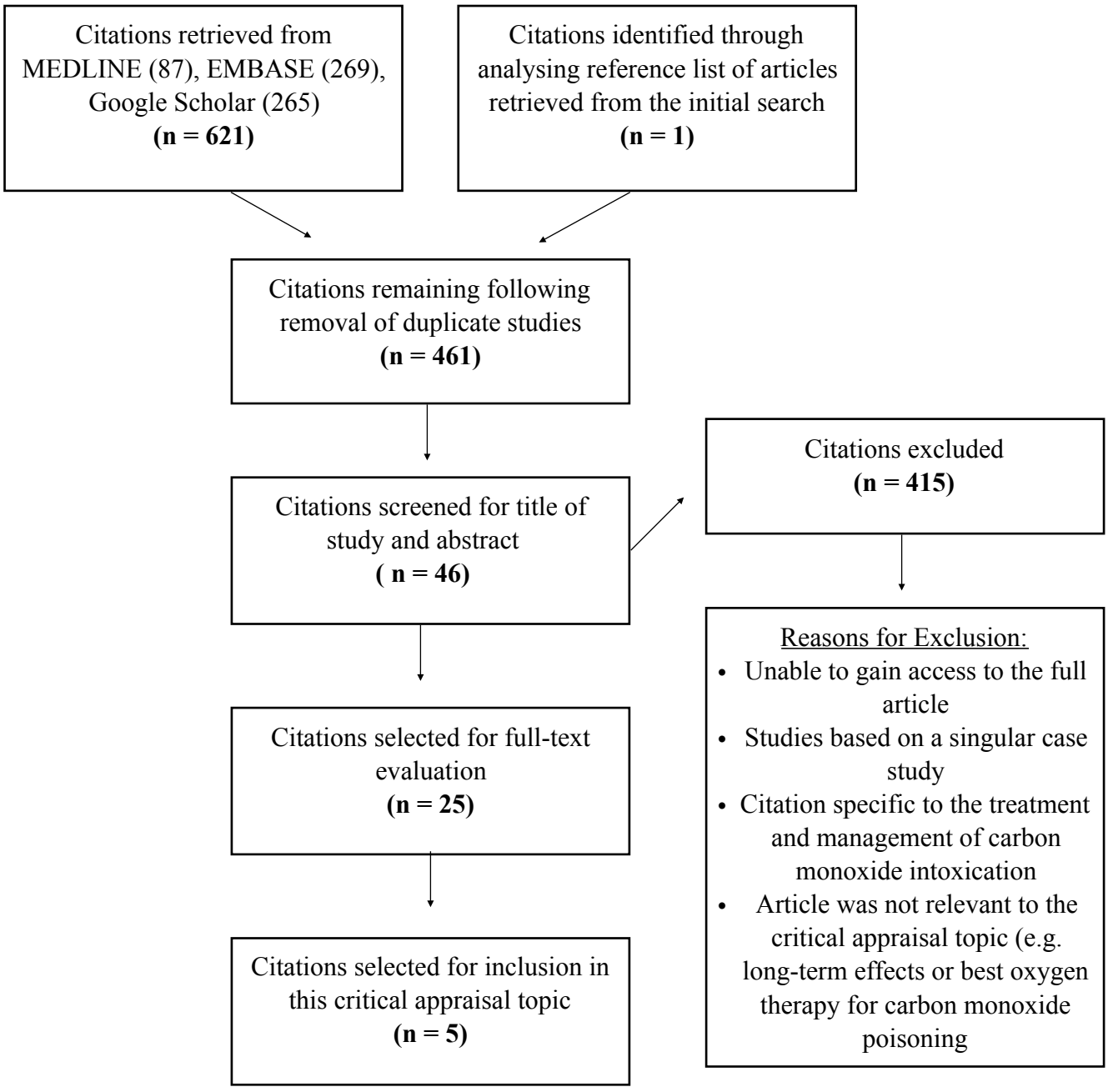

Figure 1. PRISMA diagram exhibiting the selection process of articles included in this critical appraisal topic.

Study Analysis

Author, Year	**Population**	**Study Design**	**Key Findings**	**Strengths & Limitations**	**Oxford LOE**
Balzan et al., 1996	Patients presenting to the emergency department with carbon monoxide intoxication.	Multi-centre systematic review	• The clinical features of carbon monoxide intoxication are nonspecific and are similar to other common conditions, as features can range from unconsciousness, epileptic fits, headaches, vomiting, flu-like symptoms, respiratory depression and unstable angina. • Patients can also be asymptomatic at low exposures • CO intoxication mimics common conditions including angina, drug overdosage and status epileptics.	Strengths: • Includes results from multiple research studies with large sample sizes. • Inclusivity of multiple research studies indicates that the final results concluded are supported by other literature. Limitations • The study was published in 1996, thus is outdated and requires newer literature to support the findings.	2a
Eichhorn et al., 2018	Patients who received both out-of-hospital and in-hospital treatment for carbon monoxide intoxication	Literature Review	• The clinical symptoms of CO intoxication range from dizziness and headache, to confusion, cardiac angina, loss of consciousness and death • Symptoms resemble those of influenza • The symptoms are dependant on the concentration and duration of carbon monoxide exposure • Patients with history of coronary heart disease are at a greater risk of arrhythmias and myocardial infarction from CO exposure	Strengths: • Included data from several studies • Listed the symptoms of CO intoxication and reasons for misdiagnosis Limitations: • Small case numbers • Primarily focused on comparing different treatment options for CO intoxication • Is a literature review	1b

Author, Year	**Population**	**Study Design**	**Key Findings**	**Strengths & Limitations**	**Oxford LOE**
Gorman et al., 1992	This study included 100 patient hospital admissions for carbon monoxide poisoning. Children, patients deceased on arrival and patients with involvement of other poisons were excluded from the study.	Prospective and Longitudinal Study	• The following symptoms, signs and findings were noticed in patients; headaches (55%*), acute brain syndrome (53%), dizziness (49%), loss of consciousness (46%), nausea and vomiting (26%), motor disorders (20%), abnormal ECG changes with ST/T wave depression (7%), cherry-red colouration (1%). *Percentage indicates how many participants in the study experienced the symptom	<u>Strengths:</u> • Relates to the critical appraisal topic regarding symptoms of CO intoxication <u>Limitations:</u> • Small sample size • Outdated article • Based in one location • Children are excluded from the study • Based on hospital care	1b
Mehta et al., 2007	Patients with CO intoxication and blood COHb concentration percentage ranging from 15 to > 70%.	Systematic Review	• The main findings in detail are exhibited in figure 2. • Overall clinical manifestations include headache, muscle weakness, nausea, vomiting, confusion, tachycardia, seizures, coma, respiratory failure and death. • Symptoms and signs of CO poisoning mimics several nonspecific viral illnesses • In children, vomiting may be the sole presenting symptom, leading to misdiagnosis of other conditions such as gastroenteritis	<u>Strengths:</u> • Findings are associated with the topic of the critical appraisal • Provides data regarding symptoms of patients exposed to both low and high levels of carbon monoxide • Findings are supported by several other literature <u>Limitations:</u> • The article is a systematic review	2a

Author, Year	Population	Study Design	Key Findings	Strengths & Limitations	Oxford LOE
Mehta et al., 2007 cont.			• Patients with coronary artery disease may experience associated symptoms of myocardial ischaemia, which may potentially result in myocardial infarction • CO exposure can exacerbate pre-existing diseases such as ischaemic heart disease or dementia • Low level chronic CO intoxication results in behavioural abnormalities, memory difficulties, chronic cough or diarrhoea. • CO intoxication can be misinterpreted as chronic fatigue syndrome, a bacterial, viral, pulmonary or gastrointestinal infection or immune deficiency.		
Roth et al., 2013	Patients with CO poisoning as a result of exposure. Participants also included the attending paramedics and bystanders who were also poisoned.	Prospective, observational, non-controlled study	• The leading symptoms of carbon monoxide poisoning are headache, loss of consciousness and dyspnea. • Due to lack of established standards, the diagnosis of CO poisoning is significantly difficult in the prehospital setting • The main symptoms of carbon monoxide symptoms examined in the patients involved in this study are exhibited in table 3.	<u>Strengths:</u> • Findings were related to the topic of this critical appraisal <u>Limitations:</u> • Small sample size • Paramedics were equipped with carbon monoxide detectors, thus misdiagnosis was unlikely as they could measure CO exposure in the prehospital setting	1b

Abbreviations: CO; carbon monoxide; COHb; carboxyhemoglobin

Consideration for Practice

Based on the literature reviewed, it is found that the symptoms of carbon monoxide (CO) poisoning are nonspecific and are often misdiagnosed as they mimic common conditions such as influenza, unstable angina or gastroenteritis (Mehta et al., 2007). Examination of cherry red skin colouration is considered the hallmark feature of CO poisoning, however, several literature have identified the that this feature is not commonly present in patients with this condition. One study concluded that cherry red skin was found in only 1% of patients with CO intoxication and requires fatal levels of exposure before it is evident (Gorman et al., 1992) Therefore, due to these ideologies of the presentation of CO intoxication, it is often misdiagnosed and not considered by by paramedics.

Findings concluded that the most common symptoms found in patients include headache, dizziness, confusion, cardiac angina, vomiting and nausea (Eichhom et al., 2018). It can be acknowledged that carbon monoxide poisoning does not have a gold standard symptom and will continue to result in diagnostic errors due to ambiguous clinical manifestations. Overall, health practitioners should have a high index of suspicion of CO intoxication in all patients presenting with vague symptoms, however, additional prehospital tests are required to successfully diagnose this condition in the prehospital setting.

In addition, it must be acknowledged that there was significant difficulty in locating recent, relevant literature on this topic, thus further studies are required on this topic to strengthen current findings.

Clinical Bottom Line

Carbon monoxide poisoning does not have a specific hallmark feature to determine a diagnosis in the prehospital setting. When treating patients with vague symptoms and possible exposure to CO, intoxication should always be considered as a differential diagnosis, especially

when multiple patients in an enclosed space are involved. Overall, recognising carbon monoxide poisoning is significantly difficult and should not rely on specific symptoms for diagnosis in the prehospital setting.

Appendix

Blood COHb concentration (%)	Clinical Manifestation
15 - 20	Mild headache, easy fatigability
20 - 30	Pounding headache, impaired motor dexterity, blurring vision, irritability
30 - 40	Severe muscle weakness, nausea, vomiting, mental confusion or delirium
40 - 50	Tachycardia, cardiac irritability
50 - 60	Seizures, respiratory insufficiency
> 60 - 70	Coma, respiratory failure, death

Figure 2. Main symptoms presented in patients with carbon monoxide intoxication and the corresponding blood COHb concentration associated with each symptom (Mehta et al., 2007).
Abbreviations: COHb; carboxyhemoglobin

	Carbon monoxide concentration measured	
Symptoms	**30 - 60 ppm (n=9)**	**> 60ppm (n = 85)**
Headache	0 (0%)	29 (34.1%)
Loss of consciousness	1 (11.1%)	7 (8.2%0
Clouding of consciousness	1 (11.1%)	6 (7.1%)
Dyspnea	0 (0%)	6 (7.1%)
Syncope	2 (22.2%)	3 (3.5%)
Vertigo	0 (0%)	3 (3.5%)
Emesis	0 (0%)	2 (2.4%)
Fever	0 (0%)	2 (2.4%)
Nausea	0 (0%)	2 (2.4%)
Generalised pain	0 (0%)	1 (1.2%)
Thoracic pain	1 (11.1%)	1 (1.2%)
Abdominal pain	1 (11.1%)	0 (0%)
Patient deceased on arrival	0 (0%)	1 (1.2%)
Other/unknown	3 (33.3%)	22 (25.9%)

Figure 3. Symptoms experienced by patients with differing severity of carbon monoxide poisoning (Roth et al., 2013)
Abbreviations: ppm; parts per million; n; number of participants

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