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SCIENTIFIC LETTERS

Effect of the global blackout in Spain exposure to carbon monoxide in Catalonia

Efecto del apagón global en Spain sobre la exposición al monóxido de carbono en Cataluña

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On April 28, 2025, the entire Spanish mainland experienced a widespread power outage, accompanied by the failure of most telecommunications systems, prompting the declaration of a national emergency.[1] This dual disruption forced the population to adapt immediately to the prolonged interruption of electricity and communications. The impact was widespread, with significant repercussions for healthcare, economic activity, and employment. The shutdown of industry, services, commerce, and transportation generated substantial economic losses, estimated at a 0.1% reduction in quarterly national gross domestic product (less than €400 million).[2] Emergency services and hospitals were forced to activate contingency plans to ensure the provision of care in critical areas, while the 112 emergency telephone system remained only partially operational in some areas. Although knowledge of the overall impact on the population remains limited, significant vulnerabilities were identified, including the suspension of scheduled healthcare activities, communication difficulties, and problems with home oxygen therapy among patients with limited access to backup power supplies.[3] The power outage began at 12:33 p.m., and electricity was not fully restored until more than 14 hours later.[4] The exact number of deaths directly attributable to the blackout remains unknown, although at least 10 fatalities have been reported in Spain.[5]

We present the experience of the Sistema d'Emergències Mèdiques (SEM), in collaboration with 1 of the 2 reference centers for hyperbaric oxygen therapy (HBOT) serving a population of approximately 8 million inhabitants in Catalonia. The objective was to describe the epidemiology and clinical and therapeutic characteristics of patients treated for carbon monoxide (CO) exposure during the blackout in Catalonia.

We conducted a longitudinal observational study through a review of case report records and follow-up data. The study is part of a research incentive grant whose protocol was approved by the Research Ethics Committee for Medicinal Products of the Institut d'Investigació Sanitària Pere Virgili (CEIm reference: 003/2025). During the emergency and the subsequent hours, the three emergency medical dispatch centers received 7,153 calls, of which 2,256 (31.5%) required the deployment of mobile emergency medical resources, including both basic and advanced life support units. Thirteen incidents involving 30 individuals affected by acute CO poisoning were identified, mainly resulting from the accidental combustion of fuel in generator engines, predominantly in residential settings and, in two cases, in the workplace.

Table 1 summarizes the epidemiological, clinical, laboratory, and therapeutic characteristics of the 30 affected individuals. The mean age was 43 years (SD, 21.6), and 50% were women. The mean duration of CO exposure was 7.8 hours (SD, 1.4). The most common symptoms were dizziness (63.3%), weakness (60%), and headache (53.3%). The mean initial Glasgow Coma Scale score was 14 (14–15). Although this scale is nonspecific in patients with poisoning, it is widely used.[6] In these cases, neurological assessment using early warning scoring systems such as NEWS2 or other proposed scales may be more appropriate.[7-9] Nevertheless, early detection and documentation of the level of consciousness are essential as indicators of clinical deterioration and for identifying higher-risk patients requiring close monitoring.[6] All affected individuals received prehospital high-concentration oxygen through a non-rebreather mask with a reservoir bag, in accordance with established clinical protocols and quality standards,[10] before being transported to the emergency department of the designated referral hospital.

Of the 30 patients treated, 16 were transferred to the hyperbaric therapy unit (HTU), of whom 13 (81.3%) required HBOT. The indication for HBOT was established according to the usual clinical criteria for CO poisoning, including elevated carboxyhemoglobin (COHb) levels, neurological symptoms, altered level of consciousness, prolonged exposure, or persistent symptoms after normobaric oxygen therapy. During the initial prehospital assessment, the mean percentage of CO-bound hemoglobin saturation measured by portable noninvasive pulse CO-oximetry (SpCO) was 23% (SD, 16.3). Among patients treated with HBOT, COHb levels were 19.5% (SD, 11.3). However, comparisons between these values are limited by differences in measurement methods (noninvasive pulse CO-oximetry in situ vs COHb measurement in the emergency department),[11,12] as well as clinical variability resulting from removal from the exposure source, early oxygen administration, and the duration of oxygen therapy. Two patients treated with HBOT (12.5%) required hospitalization, neither in an intensive care unit, and both were discharged without complications. All patients underwent clinical follow-up at 30, 90, and 180 days and remained asymptomatic.

A detailed medical history, early diagnosis, and prompt initiation of high-concentration oxygen therapy are essential to prevent sequelae of CO poisoning. Multidisciplinary clinical protocols should be established to ensure follow-up of these patients and identify factors associated with an increased risk of delayed neurological syndrome.[6] Mortality from accidental CO poisoning has decreased worldwide over the past 2 decades.[13] Nevertheless, this exposure is potentially preventable through public education about CO sources and the risks associated with using combustion devices indoors without adequate ventilation or CO detectors. Continuous training of health care professionals in the early recognition of poisoning[13] and strengthened public health surveillance and communication during and after emergencies[14] are also essential to reduce associated morbidity and mortality.

Similar situations have been described during other disruptive events, such as hurricanes and winter

Table 1. Epidemiological, clinical, and treatment characteristics of affected individuals according to care received and disposition

	Patients treated at the scene N = 30 n (%)	Patients transferred to an HTU N = 16 n (%)
Epidemiological data		
Age (years), [mean (SD)]	43 (21.6)	28.48 (22.4)
Female sex	15 (50)	7 (43.7)
Times (hours), [mean (SD)]		
Exposure duration	7.8 (1.4)	–
Time to arrival at HTU	–	4.5 (1.2)
Clinical data		
Symptomatic patients	24 (80.0)	13 (81.3)
Dizziness	19 (63.3)	5 (31.3)
Weakness	18 (60.0)	8 (50.0)
Headache	16 (53.3)	10 (65.3)
Vomiting	4 (13.3)	–
Transient loss of consciousness	3 (10.0)	5 (31.3)
Seizures	2 (6.6)	–
CO measurements [mean (SD)]		
Initial prehospital SpCO (%)	23 (16.3)	19.5 (11.3)
COHb (%) before HBOT	–	6.7 (3.2)
COHb (%) after HBOT	–	1.2 (0.6)
Oxygen therapy		
Normobaric oxygen via non-rebreather mask	30 (100)	3 (18.7)
HBOT	–	13 (81.3)
Transfer data		
Transfer to ED	30 (100)	–
Transfer to HTU	16 (53.3)	–
Transfer by ALS unit	12 (40.0)	–
Transfer by BLS unit	18 (60.0)	–
Outcome data		
Hospitalization	–	2 (12.5)
Clinical resolution	–	16 (100)
Follow-up for DNS	–	16 (100)
Presence of DNS (30, 90, and 180 days)	–	0 (0)

ALS: advanced life support; BLS: basic life support; COHb: percentage of carboxyhemoglobin in blood; DNS: delayed neurological syndrome; ED: emergency department; HBOT: hyperbaric oxygen therapy; HTU: hyperbaric therapy unit; SD: standard deviation; SpCO: percentage of CO-bound hemoglobin saturation measured by portable noninvasive pulse CO-oximetry.

storms, in which the use of household generators and combustion in enclosed spaces constitute the main sources of CO exposure.[14] In this study, a substantial number of patients were referred to the HTU, which might initially be interpreted as possible overutilization of resources. However, during population-wide emergencies characterized by prolonged exposures and considerable clinical uncertainty, clinical protocols generally favor cautious triage strategies to avoid underdiagnosis of potentially severe cases. Referral for specialist assessment and possible hyperbaric treatment was based on established clinical criteria for CO poisoning, including neurological symptoms, elevated COHb levels, or prolonged exposure. From this perspective, the observed healthcare response may be considered appropriate and aimed at minimizing the risk of delayed neurological sequelae. Nevertheless, the retrospective design, small sample size, and potential selection bias limit the generalizability of the findings and suggest the need for multicenter studies in similar settings. In conclusion, the findings of this case series describe a temporary increase in CO poisoning associated with the use of combustion devices during an emergency. This highlighted the need to update the specific protocol for managing incidents involving multiple affected individuals to improve internal coordination, clinical prioritization, and response efficiency during future emergencies and adverse events.

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