FIELD MEDICINE

RENAL AND NEUROPSYCHIATRIC MANIFESTATIONS OF CARBON MONOXIDE POISONING

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INTRODUCTION

Carbon monoxide (CO) is a highly toxic, odorless, colorless, tasteless, and nonirritating gas. The most common causes of CO exposure are fires, faulty combustion heating systems, exhaust from internal combustion engines, and heating gases. When breathed in, CO competes with oxygen in the blood, binding to hemoglobin in place of the oxygen and interfering with the oxygenation of tissues. The affinity of CO to hemoglobin is approximately 200 times greater than that of oxygen, making it a very effective mechanism to displace oxygen [1]. Although the neurotoxicant effect of CO exposure was initially believed to be a result of hypoxia secondary to the displacement of oxygen, it is now believed that additional mechanisms are involved, including the suppression of mitochondrial oxidative respiration and cardiomyopathy, with the associated hypotension and systemic acidosis. The clinical signs and symptoms of carbon monoxide poisoning vary, but in general, symptom severity correlates with carboxyhemoglobin (COHb) level. Symptoms can manifest suddenly but are relatively nonspecific (eg, headache, dizziness, weakness, nausea, visual disturbances, and confusion) [2]. The brain and heart are very sensitive to carbon monoxide poisoning; other organs are also affected. Studies support the fact that delayed neuropsychiatric symptoms may occur 3 to 240 days after exposure, after apparent recovery from acute intoxication [3,4]. Diagnosis of CO toxicity is based upon history of exposure to the source, physical examination and COHb levels if facility is available. We are reporting the first case from any hospital of Armed forces.

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CASE REPORT

The patient under discussion is a 62 year old non-smoker male with no background history of diabetes mellitus, ischemic heart disease, hypertension or any other medical or surgical ailment. The victim was found unconscious one morning in the closed room where he had slept the whole night with the gas heater on. According to the relatives he was alright before sleeping that night. He was taken immediately to a peripheral hospital where emergency management was done, suspecting CO poisoning. He regained consciousness within hours with the administration of oxygen. His initial baseline investigations which included blood complete picture, urine routine examination, cardiac enzymes, and hepatic and renal profiles were essentially normal. Next day his condition started deteriorating with progressively reducing conscious level and generalized weakness. His urine output started declining and he became anuric. Investigations were repeated and they revealed Hb 11.2g/dL , TLC 12.6×109/L, serum urea was 29.5 mmol/L, creatinine 677.4 µmol/L ALT 99U/L. Urine RE was normal. Patient was haemodialysed urgently which led to transient improvement and was transferred to Military Hospital (MH) Rawalpindi for further management and nephrology consultation on fourth day of admission.

The patient was reassessed in MH Rawalpindi where on examination he was found to be disoriented and hypertalkative, vital signs were normal and systemic examination revealed ataxic gait.

Investigations revealed Hb 10.4 g/dl, TLC 7.8×109/L, urea 44.1 mmol/L, creatinine 1172 µmol/L, Potassium 5.6 mmol/L, urine RE showed 8 to 10 pus cells/HPF and a normal ECG. Muscle enzymes were normal. Patient was subjected to multiple myeloma, autoimmune and hepatitis serology screens, which were found negative. Ultrasound abdomen showed bilateral grade 1 renal parenchymal disease with left renal cortical cyst with normal renal sizes. Patient was managed aggressively using alternate haemodialysis and broad-spectrum antibiotics. Following second session of dialysis patient developed fever, which was high grade intermittent with a fever spike daily. Samples of blood, urine, IV lines, foley catheter tip were sent for C/S. Blood C/S revealed Meropenam sensitive K. pneumoniae. He was given Meropenem accordingly, with which his fever settled within a three days. With these efforts patient's renal profile started improving. In the mean time patient developed abnormal behavior initially he was too talkative but later on became aphasic and lost interest in eating and surroundings and became dysphagic. He was subjected to upper GI endoscopy to investigate dysphagia. During endoscopy he refused to cooperate and demonstrated untoward behaviour. Patient was shown to neurophysician and ENT specialist and no organic pathology or neurologic deficit could be found. CT scans of brain and chest were found to be essentially normal. Meanwhile he became dialysis indepedendent and renal profile normalized. He was shown to a psychiatrist who attributed the symptoms to delayed neuropsychiatric disorder secondary to carbon monoxide poisoning. Patient was prescribed Cap Fluoxetine to which he responded and his symptoms gradually improved. Within one month he started communicating and taking food and in another two weeks he started walking with support. He remained on physiotherapy throughout his illness but still developed disuse atrophy of limb muscles. After three months of start of his ailment he was symptom free and antidepressants were tapered off.

DISCUSSION

Carbon monoxide (CO) is a colourless, odorless two-molecule gas. Its toxicity accounts for great mortality and morbidity. We do not have any statistics available for our set up, in USA however, it is responsible for about 600 unintentional deaths each year [5]. Symptoms can manifest suddenly but are relatively nonspecific. Symptoms include nausea, headache, weakness, irritability, confusion, visual disturbances, Parkinsonism, persistent vegetative state, akinetic mutism, agnosia, apraxia, confabulation, depression, delirium, and psychosis. Some of these were manifested in our patient. Patients may present with flu-like symptoms or symptoms consistent with a bacterial or viral infection, and may, therefore, be misdiagnosed [6]. Patients who survive the initial poisoning still face the prospect of delayed neurologic dysfunction, which occurs in 14% to 40% of serious cases, which can persist for more than a year. In our patient the neurological symptoms persisted upto three months. The brain and heart are very sensitive to carbon monoxide poisoning; other organs are also affected. Prolonged exposures, especially those resulting in coma or altered mental status, may be accompanied by retinal hemorrhages and lactic acidosis [7]. Myonecrosis can occur, reflected by elevated creatine kinase (CK) levels, but rarely leads to compartmental syndrome or renal failure.

Symptom severity and carboxyhemoglobin levels depend on concentration of carbon monoxide in the environment, duration of carbon monoxide exposure, and interval between exposure and clinical assessment [8]. Normal carboxyhemoglobin concentrations are 2 percent or less for nonsmokers and 9 percent or less for smokers [9]. CO is formed as a by-product of burning organic compounds. Although most fatalities result from fires,

stoves, portable heaters, and automobile exhaust cause approximately one third of deaths. These often are associated with malfunctioning or obstructed exhaust systems and suicide attempts. Cigarette smoke is a significant source of CO. Our case also suffered due to incomplete combustion of the gas heater.

Toxicity primarily results from cellular hypoxia caused by impedance of oxygen delivery. CO reversibly binds hemoglobin, resulting in relative anemia. CO binds to cardiac myoglobin with an even greater affinity than to hemoglobin; the resulting myocardial depression and hypotension exacerbates the tissue hypoxia. At cellular level CO may cause brain lipid peroxidation and leukocyte-mediated inflammatory changes in the brain. Following severe intoxication, patients display central nervous system (CNS) pathology, including white matter demyelination. This leads to edema and focal areas of necrosis, typically of the bilateral globus pallidus [10]. Renal toxicity is usually the result of myonecrosis and rhabdomyolysis. In our case there was no evidence of rhabdomyolysis but possible mechanism of renal toxicity can be NO (nitric oxide) free radical mediated endothelial damage causing ischemic acute tubular necrosis [11].

Diagnosis of carbon monoxide poisoning is based on history of exposure COHb levels and CO levels in exhaled air. In this particular case the diagnosis of CO poisoning is supported by circumstantial evidence. Neuroimaging in the form of CT scan and MRI of brain, ECG, renal function tests, cardiac enzymes, chest X ray and neurophysiologic testing help in detecting complications. Although neurologic changes are usually delayed, a CT scan of the brain can reveal some changes as soon as 24 hours after severe poisoning [12]. Lucencies of the basal ganglia, especially the globus pallidus and cerebral white matter, are most commonly noted. Patients with these early changes have a poor prognosis. In one recent study, 53% of patients hospitalized for acute CO intoxication had abnormal CT scan findings; all of these patients had neurologic sequelae. Of those patients with negative scans, only 11% had neurologic sequelae [13,14]. CT scan brain of our patient was found to be normal.

Treatment for carbon monoxide poisoning consists of the immediate removal of the victim from the source. In ambient air, the half-life of carbon monoxide is 320 minutes. The use of 100 percent oxygen reduces this half-life to 80 minutes [15]. Under hyperbaric conditions (2.5 to 3 atm), the half-life of carbon monoxide is reduced even further, to about 23 minutes. Using 100 percent oxygen to treat carbon monoxide poisoning is well accepted because it is safe, convenient, and inexpensive; the use of hyperbaric oxygen treatment, however, remains highly controversial [16].

Complications of carbon monoxide poisoning can be treated with supportive measures. Occasionally seizures result, requiring routine administration of benzodiazepines. Patients with suspected coronary artery disease may benefit from an electrocardiogram, CK testing, and therapy for angina. Rhabdomyolysis may elevate CK levels and in such cases the kidneys can be protected with aggressive hydration to increase urination. Acute renal failure is to be managed with haemodialysis till recovery and psychiatric manifestations are managed with antidepressants, as was the case in our patient.

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