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Delayed neuropsychiatric impairment after carbon monoxide poisoning from burning charcoal

燒炭自殺導致一氧化碳中毒後出現的遲延性神經精神損害

Poisoning by carbon monoxide from burning charcoal has become one of the popular and lethal ways of attempting suicide in Hong Kong. Survivors of the carbon monoxide poisoning often face acute and delayed adverse problems in both their physical and mental health. We report two cases of delayed onset neuropsychiatric complications caused by carbon monoxide poisoning from burning charcoal. These symptoms were characterised by a latent period, followed by an abrupt and profound deterioration in the neurocognitive function with a seemingly reversible course. The literature is reviewed regarding the aetiology, pathophysiology, and management of this condition. Regular monitoring of their neurocognitive function and forewarning of this potential complication to the survivors of carbon monoxide poisoning and their families should be essential.

燒炭導致一氧化碳中毒為香港近年最常見的自殺致死行為，即使在獲救康復後也面對各種急性及遲延性後遺症。本文報告兩名燒炭自殺導致一氧化碳中毒的病人，在短暫康復後出現遲延性神經精神併發症。病徵多在潛伏期後呈現，繼而出現嚴重突發性和可能的可逆性神經認知功能衰退。本文亦討論這類後遺症的特性、病因和治療方法。為病者定期作神經認知檢查，以及讓他們和其家人及早認識此類後遺症，都是非常重要的。

Introduction

Carbon monoxide (CO) poisoning from burning charcoal has become a popular way of attempting suicide in Hong Kong. The incidence rate increased from 6% to 28% in the period between 1998 and 2001. Despite an increase in the overall suicidal rate during the above period, there existed a disproportional rise in CO poisonings. Burning charcoal was observed to be a substitution for other methods and became the second most common method of suicide in Hong Kong in 2001.[1] Chung and Leung[2] reported a sharp rise in the incidence of suicide by charcoal burning after an extensive coverage in the media of the first reported case in November 1998. The relationship between suicide and media has been debated for a long time. Indeed, there may be an association or even a causal relationship between them.[3,4]

Carbon monoxide poisoning can lead to considerable detrimental effects on both the physical and mental health of the suicide attempt survivors. Patients can survive even after prolonged exposure to CO because of the variability of CO accumulation and of oxygen consumption between individuals. Apart from acute complications, delayed neuropsychiatric complications due to CO poisoning have been reported previously in the literature. A large-scale epidemiological study by Choi[5] in 1983 on the delayed neuropsychiatric impairment showed that 2.75% (65/2360) of patients suffered from this complication with a mean lucid period of about 3 weeks. A more recent epidemiological study in Spain of 154 patients reported an incidence of 14.4% of CO poisoning–related delayed neuropsychiatric impairment.[6] Ernst and Zibrak[7] estimated that this delayed neuropsychiatric impairment could occur in up to 30% of survivors. We report two isolated patients who survived CO poisoning from charcoal burning that presented with delayed neuropsychiatric impairment. This article will discuss

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the aetiology, pathophysiology, clinical course, and management of this condition.

Case reports

Case 1

A 30-year-old married woman attempted a suicide pact with her husband by burning charcoal in an enclosed space in a premeditated manner. Apart from burning charcoal, they also took an unknown amount of hypnotic drugs. They were found to be unconscious after 13 hours of exposure to CO from the burning charcoal. Her husband remained comatose for a prolonged period and suffered from immediate profound neuropsychiatric damage. The woman had a carboxyhaemoglobin (COHb) level of 31% on arrival to Accident and Emergency Department, which was dropped to 0.3% after receiving hyperbaric oxygen therapy for 1.5 hours. She recovered with no overt neurological deficit after 3 days of coma. An antidepressant drug (fluoxetine) was prescribed for her depression on day 12. Her mini mental state examination (MMSE) score was 28/30 on admission to the psychiatric ward. Three weeks after CO poisoning, she ran a rapid downhill course with disorientation, apathy, marked global cognitive impairment, and double incontinence. Close supervision and assistance was required in her daily living activity, such as bathing and grooming. The MMSE score dropped to 11/30 in week 6 (Fig). Her blood tests showed no abnormality but there was a small focus of lacunar infarct in left lentiform nuclei as shown in the brain magnetic resonance image (MRI). Vitamin E (up to 1600 IU/d) was prescribed soon after the acute deterioration because of its antioxidant effect. The clinical progress was paralleled by the improvement as documented in the detailed serial cognitive examination. She returned to her previous functioning level after a further 6 weeks. On discharge home, she lived independently, coped with her finances, and was capable of taking care of her severely demented husband.

Case 2

A 47-year-old married waitress, who suffered from depression, attempted suicide by burning charcoal in her sealed flat. She was discovered after 8 hours of exposure to the charcoal fumes. The COHb level was 46.7% at admission and she was comatose for 3 days. She received 100% oxygen at normal pressure and her COHb level decreased to 0% within 5 hours after being rescued, and she recovered with no major neurological sequelae. There was no available information on why she did not receive hyperbaric oxygen. On day 7, she was transferred to the psychiatric ward for further management of her depression and was prescribed an antidepressant drug (fluoxetine). She had an MMSE score of 28/30 on admission and her cognitive function showed considerable deterioration by week 2 and her MMSE score dropped to 12/30 in week 6 (Fig). She was increasingly forgetful, disorientated, and showed difficulty in performing simple tasks that she could previously perform. She lost her way in familiar places and failed to carry out self-care activities like bathing. No prominent extra-pyramidal feature was elicited. She became incontinent and finally developed a seizure with twitching of right upper limb, and she lapsed into unconsciousness. Her prolactin level was found to be 4000 mIU/L on the day of the seizure attack and it decreased to less than 150 mIU/L 2 weeks later. The blood tests were normal and the computed tomography (CT) of the brain showed small lacunar infarcts in bilateral lentiform nuclei. This acute deterioration was followed by progressive improvement, and the cognitive assessments also showed this reversible course.

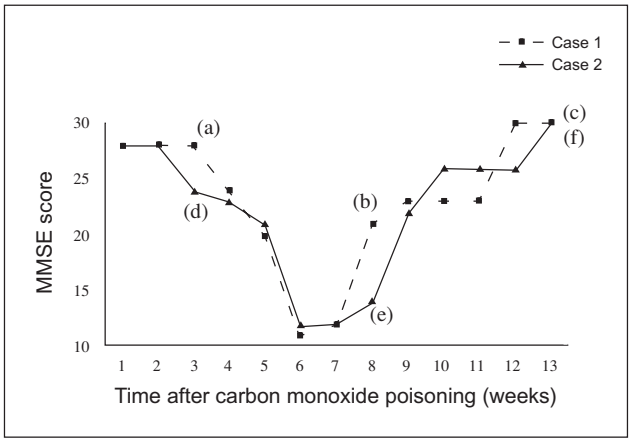

Fig. Serial mini mental state examination (MMSE) score and cognitive assessment results of cases 1 and 2

Case 1

(a) Week 3
1. Full-scale IQ (FIQ)=76 (comparable to her educational level and premorbid functional level)
2. Memory tests (Hong Kong List Learning Test and Wechsler Memory Scale-Revised [WMS-R]): no significant deficit
3. Executive functions (verbal fluency test): moderate impairment

(b) Week 8
1. FIQ=58 with verbal-performance discrepancy of 18
2. Memory tests: signs of confabulation and verbal perseveration
3. Executive functions: severely impaired
4. Presence of parietal lobe involvement: finger agnosia, L-R disorientation, acaculia, apraxia in ideomotor, ideopraxia, dressing and constructional aspects

(c) Week 13
1. FIQ=76
2. Memory tests: no significant deficit
3. Executive functions: residual impairment
4. Resolution of the parietal lobe signs

Case 2

(d) Week 3
1. Memory tests (Hong Kong List Learning Test): moderate impairment
2. Executive functions (card-sorting test, verbal fluency test and similarities test): below average

(e) Week 8
Significant impairment in both memory and executive functions. Presence of verbal perseveration

(f) Week 13
Memory function improved and had mild impairment only. No deficit in executive functions. Perseveration resolved

Four months after the CO poisoning incidence, she resumed her work and maintained gainful employment. However, she complained of residual forgetfulness and subjectively had declined working performance compared with her past.

Discussion

Patients with delayed neuropsychiatric impairment due to CO poisoning apparently have a lucid period of between 2 and 4 weeks before the appearance of a progressive decline in their neurocognitive functions.[5] The typical presentation included apathy, disorientation, amnesia, extra-pyramidal symptoms, incontinence, psychosis, global cognitive impairment, seizure, and coma.[7,8]

Our two patients illustrated this clinical course with the delay emergence of encephalopathy. This is characterised by a delayed period lasting for 3 weeks, followed by an abrupt and profound neurocognitive deficit in a seemingly reversible 'V-shape' pattern. A series of neuropsychiatric tests were performed in a longitudinal course including MMSE, IQ score, and tests of memory, attention, executive and parietal lobe functions. As early as week 2, the detailed neuropsychological examinations already revealed subtle defects in the memory, attention, and executive functions of the two patients. Similar early neuropsychological deficits among patients at 2 weeks after CO poisoning were also reported by Parkinson et al[9] and Weaver et al.[10] Although MMSE was able to demonstrate the global cognitive deficit, it was not, however, sensitive enough to pick up the subtle defects either at the early decompensation or in the recovery phase. The MMSE score in our patients were both above 28/30 during the early and late recovery phases despite the persistent deficits as demonstrated by the psychometric tests. This might suggest that an early and serial administration of detailed neurocognitive test soon after the CO poisoning would better identify the subtle cognitive deficits than MMSE. Although Choi[5] reported that 75% of his patients recovered within 1 year from this delayed complication clinically (as defined by the resolution of gross clinical symptoms and neurological signs), there existed a possibility of residual deficits that could only be demonstrated by detailed neurocognitive tests.

There remains a paucity of findings regarding the risk factors for this delayed neuropsychiatric impairment. The level of COHb has not been shown to be correlated with the severity of the acute toxicity symptoms.[7] Choi[5] reported that the incidence of delayed neuropsychiatric sequelae tended to increase in accordance with the duration of unconsciousness during an acute intoxication. Deschamps et al[11] reported that only some of the memory functions (quality of learning and immediate visual memory) were positively correlated with the initial CO level, but this correlation was not seen in other memory and attention tests. Thus, it is still controversial as to whether there is any dose-dependent effect on the pathogenesis of this delayed neuropsychiatric impairment.

Globus pallidus has been shown, using functional imaging, to be one of the most frequently injured areas during the acute stage.[12] Basal ganglia infarct has also been reported to occur in association with expressive language problems,[13] movement disorders (eg dystonia, chorea, parkinsonism), and behavioural disturbance (eg abulia, disinhibition, obsessive compulsive symptoms).[14] However, one of our patients also presented with parietal lobe signs during the course of their illness, which could not be explained by the basal ganglia lesions alone. White matter hyperintensities were reported in cases of established delayed encephalopathy.[9,12] Although white matter hyperintensities was not detected in our two patients using CT or MRI, the presence of white matter lesions could not be excluded without the more advanced imaging, such as diffusion-weighted MRI[15] and diffusion tensor imaging,[16] which are more sensitive in the detection of white matter lesions. However, some patients show delayed neurocognitive symptoms who did not have any brain abnormalities as detectable using CT or MRI,[17] making the correlation between the neurocognitive symptoms and positive imaging findings even more equivocal. Imaging techniques, which detect abnormalities in cerebral blood flow in the affected areas (eg positron emission tomography and single photon emission computed tomography), might be more sensitive and hence, better correlate the symptoms with the clinical course.[12,18]

The underlying pathophysiology of this delayed phenomenon remains controversial; hypoxia alone is insufficient to explain this whole scenario. Cellular theories have been proposed, such as immuopathological damage, disturbance of dopaminergic and serotonergic functions, and the role of CO as an endogenous neurotransmitter.[12] The immuopathological theory postulates that the delayed but reversible effects were related to the activation of polymorphonuclear leukocytes by the CO, leading to reversible demyelination of the central nervous system. This is further supported by the MRI finding of white matter hyperintensities, which might be caused by demyelination after CO poisoning.

Regarding the management of CO poisoning, oxygen therapy including the use of hyperbaric oxygen has been for years the mainstay treatment of acute cases. The underlying mechanism involves the increase in dissolved-oxygen content in blood accelerating the process of CO elimination and hence, preventing lipid peroxidation in the brain.[19] Despite this appealing hypothesis, clinical trials have given conflicting results regarding its efficacy in preventing delayed neuropsychiatric complication.[7,20] In our first case, the hyperbaric oxygen did not prevent the patient from developing delayed neuropsychiatric impairment. In the absence of firm evidence, hyperbaric oxygen is still recommended for those patients with high COHb level (above 25%-30%[21]) and with signs suggesting severe poisoning,[7,19] such as coma or neurological signs on presentation.

In CO poisoning, oxidative stress takes place during the ischaemic and re-perfusion phases, and also during the process of the oxygen therapy. Theoretically, the use of antioxidants may prevent the side-effects of increased oxidative stress; however, it was reported that vitamin E compounds could instead act as pro-oxidants and might accelerate lipid peroxidation.[22] Further research is needed to clarify the role of antioxidants in the treatment of delayed neuropsychiatric impairment.

Our cases illustrated that besides treating the immediate complications of CO poisoning, clinicians should also need to be aware of the delayed complications among the survivors, which commonly occurs from 2 to 4 weeks after the acute poisoning. Serial MMSE did show a parallel deterioration with the clinical course, yet it was not able to give any warning signals in the early stage. It seems that neuropsychiatric memory tests (eg the Hong Kong List Learning Test) and executive function tests (eg verbal fluency, motor sequencing, and proverb interpretation) are more capable of early detection. Furthermore, these tests are simple and convenient to be performed by clinical staff. Nevertheless, it should be essential to regularly follow up and monitor the neurocognitive functions of these patients, and to warn them and their families of this potential complication.

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