Available online at www.sciencedirect.com

ScienceDirect

Journal of the Chinese Medical Association xx (2018) 1−9

www.jcma-online.com

Original Article

Myocardial injury was associated with neurological sequelae of acute carbon monoxide poisoning in Taiwan

Mau-Sheng Lin [a,b,c], Chun-Chi Lin [d,e], Chen-Chang Yang [a,e,f,*], Shu-Chuan Weng [g], Shun-Mu Wang [h,i,j], Chuan-Yu Chen [a,k], Nicole Huang [a,l], Yuan-Hwa Chou [m,n]

[a] *Institute of Public Health, National Yang-Ming University, Taipei, Taiwan, ROC*
[b] *Department of Emergency Medicine, Dajia Lees General Hospital, Lees Medical Corporation, Taichung, Taiwan, ROC*
[c] *Department of Emergency Medicine, Far-Eastern Memorial Hospital, New Taipei City, Taiwan, ROC*
[d] *Division of General Medicine, Department of Medicine, National Yang-Ming University Hospital, Yilan, Taiwan, ROC*
[e] *Institute of Environmental and Occupational Health Sciences, National Yang-Ming University School of Medicine, Taipei, Taiwan, ROC*
[f] *Division of Clinical Toxicology and Occupational Medicine, Department of Medicine, Taipei Veterans General Hospital, Taipei, Taiwan, ROC*
[g] *Bachelor's Degree Program of Golden-Age Well-being Management, Yuanpei University of Medical Technology, Hsinchu, Taiwan, ROC*
[h] *Department of Public Health, China Medical University, Taichung, Taiwan, ROC*
[i] *Department of Health Services Administration, China Medical University, Taichung, Taiwan, ROC*
[j] *Department of Biotechnology and Pharmaceutical Technology, Yuanpei University of Medical Technology, Hsinchu, Taiwan, ROC*
[k] *National Health Research Institutes, Miaoli, Taiwan, ROC*
[l] *Institute of Hospital and Health Care Administration, National Yang-Ming University, Taipei, Taiwan, ROC*
[m] *Section of Community Psychiatry, Department of Psychiatry, Taipei Veterans General Hospital, Taipei, Taiwan, ROC*
[n] *Department of Psychiatry, Faculty of Medicine, National Yang-Ming University School of Medicine, Taipei, Taiwan, ROC*

Received October 4, 2017; accepted December 20, 2017

Abstract

Background: Carbon monoxide (CO) poisoning has recently become a serious health problem in some Asian countries, including Taiwan. The aims of this study are to evaluate the changing trend of CO poisoning and to demonstrate the association between myocardial injury and neurological sequelae of CO poisoning in Taiwan between 1990 and 2011.

Methods: This retrospective cohort study included all eligible patients with acute CO poisoning reported to the Taiwan National Poison Control Center during the study period. The changing trend of CO poisoning and its impacts on the primary outcomes, i.e., persistent neurological sequelae (PNS) and delayed neurological sequelae (DNS), were then assessed.

Results: 786 CO poisoned cases were reported. Among them, 467 cases were intentional. Intentional CO exposure started to become the major cause of CO poisoning in Taiwan in 2002. Increase in the number of intentional CO poisoning significantly correlated with the increase in the overall number of CO poisoning ($r = 0.972$, $p < 0.001$). Patients who took tranquilizer (OR = 3.89; 95% CI:1.94−7.77), had myocardial injury (OR = 1.70; 95% CI:1.03−2.82), had been stayed in intensive care unit (OR = 2.03; 95% CI:1.13−3.62), presented with GCS less than 9 (OR = 4.05; 95% CI:2.32−7.08) and had abnormal brain image (OR = 14.46; 95% CI:5.83−35.83) had a higher risk of PNS. Moreover, patients who were older age (OR = 1.04; 95% CI:1.02−1.07), had psychiatric disorder history (OR = 2.82; 95% CI:1.35−5.89), had myocardial injury (OR = 1.33; 95% CI:1.16−1.53), and presented with GCS less than 9 (OR = 3.23; 95% CI:1.65−6.34) had a higher risk of DNS.

Conclusion: The pattern of CO poisoning had changed markedly during the study period, with a significant increase in both the numbers of intentional and overall CO poisoning. Moreover, intentional CO poisoning was associated with a higher risk of neurological sequelae, which was mediated by various indicators of poisoning severity such as myocardial injury and GCS less than 9.

Conflicts of interest: The authors declare that they have no conflicts of interest related to the subject matter or materials discussed in this article.

* Corresponding author. Dr. Chen-Chang Yang, Institute of Environmental and Occupational Health Sciences, National Yang-Ming University School of Medicine, 155, Section 2, Linong Street, Taipei 112, Taiwan, ROC.

E-mail addresses: ccyang@vghtpe.gov.tw, ccyang2@ym.edu.tw (C.-C. Yang).

https://doi.org/10.1016/j.jcma.2017.12.006

Keywords: Acute CO poisoning; Charcoal-burning; Delayed neurological sequelae; Persistent neurological sequelae

1. Introduction

Carbon monoxide (CO) is a colorless, odorless, tasteless, and nonirritating gas and also a common lethal toxicant.[1−7] Adverse health effects associated with CO exposure range from subtle cardiovascular and respiratory effects to neuropsychiatric presentations and other systemic complications or even fatality.[1,2,6-9]

Acute CO poisoning is possibly the cause of more than 50% of all fatal poisonings in numerous industrial countries.[2,3,5,6,10] In Taiwan, the annual mortality rate of CO poisoning had markedly increased from 0.1 to 5.1 per 100,000 population during 1998−2010.[11] The pattern of CO poisoning has also changed in other Asian countries, with an increase in the incidence of charcoal-burning related suicide.[12]

In Hong Kong, charcoal-burning became the second most common suicide method in 2002, with the highest incidence in people aged 24−39 years.[13] Similarly, by then it had also become the most common suicide method for those aged 25−44 years in Taiwan. The incidence of charcoal-burning related suicide rose from 0.22 in 1999 to 6.48 per 100,000 population in 2006.[14] Charcoal-burning was the second leading suicide method in Taiwan in 2006 and accounted for one third of suicide deaths.[14,15]

In addition to a high mortality rate, acute CO poisoning may lead to persistent neurological sequelae (PNS) or delayed neurological sequelae (DNS).[1−3,8,10,16,17] PNS is a direct result of hypoxic brain damage, which is defined as the neurological symptoms evident at presentation that persist throughout hospitalization. By contrast, DNS frequently occurs within a few weeks after an initial clinical recovery from acute CO poisoning and its incidence could range from 3% to 40%.[1−4,6,8,17−21] Despite the frequent occurrence of PNS, no studies have been conducted on the risk factors of PNS. With regard to DNS, several important risk factors have been reported, including older age, duration of CO exposure, transient loss of consciousness, lower Glasgow Coma Scale (GCS) score, shorter lucid interval, and leukocytosis.[21,22] Myocardial injury has also been argued as a frequent consequence,[23−25] and is found to predict mortality and DNS in patients with CO poisoning.[21,25−28]

The major pattern of CO poisoning during the previous 2 decades in Taiwan remains unclear. Moreover, literature concerning the relationship between different patterns of CO poisoning and their outcomes is limited and the differences in the risk factors of PNS and DNS among cases of CO poisoning are not fully understood. This study aimed to explore the changes in CO poisoning patterns and their outcomes, and to determine the association between myocardial injury and neurological sequelae among those patients reported to the Taiwan National Poison Control Center (PCC) during 1990−2011.

2. Methods

2.1. Data source and study population

The protocol of this retrospective cohort study was approved by the Institutional Review Board of the Taipei Veterans General Hospital (VGH IRB No. 2011-09-007 IC). The study population consisted of all patients with CO poisoning reported to the Taiwan National PCC between January 1, 1990 and December 31, 2011. We first searched the computerized database of the Taiwan National PCC to identify all telephone inquiries concerning acute CO exposure during the study period, and reviewed the case profiles of all CO-exposed subjects. The diagnosis of acute CO poisoning was made when the subject had a clear history of CO exposure and an initial carboxyhemoglobin (COHb) level greater than 5% in non-smokers and over 10% in smokers. Subjects with unrelated exposures, cases with inadequate general information, cases with information inquiry only and cases with chronic or unknown CO exposure were excluded. We further followed all CO poisoned patients until December 31, 2013 by using their medical records.

2.2. Definition of variables

Data on the date of inquiry; patient's age, gender, personal history (i.e., smoking and drinking habits), intent of exposure; elapsed time to emergency department (ED) presentation (if available); clinical manifestations, comorbidities, treatments, and outcomes were abstracted onto a standardized form. Any disagreement during data review and abstraction process between the authors was resolved by consensus. The intent of CO exposure was classified as intentional (subjects with voluntary CO exposure such as charcoal-burning) and unintentional (subjects with accidental CO exposure such as incomplete combustion of water heater). The information on the intent of exposure was identified by treating physician at the ED and was recorded in the medical records.

Clinical data on CO poisoned patients such as the presence of any comorbidity, initial manifestations of CO poisoning (upon arrival at the ED), treatments and outcomes were collected from their medical records. Comorbidities included in this study were hypertension, diabetes mellitus, cerebrovascular disease, coronary artery disease, congestive heart failure, chronic obstructive pulmonary disease, hyperlipidemia, anemia, and psychiatric disorders (e.g., major depression, bipolar disorder, anxiety, and schizophrenia). Initial

Please cite this article in press as: Lin M-S, et al., Myocardial injury was associated with neurological sequelae of acute carbon monoxide poisoning in Taiwan, Journal of the Chinese Medical Association (2018), https://doi.org/10.1016/j.jcma.2017.12.006