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Analysis of Patients Presenting to Referral Emergency Department with Carbon Monoxide Poisoning in Jordan

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Abstract: Carbon monoxide (CO) is a colourless, odourless gas produced by incomplete combustion of carbonaceous material. Carbon monoxide poisoning is a commonly overlooked or misdiagnosed and usually present a diagnostic and treatment challenge. Treatment options remain controversial and vary among centres due the limited numbers of definitive clinical studies. The main aim of this study is to examine patients suspected of having CO gas poisoning, their symptoms and management in the emergency department at Jordan. In here, a retrospective study that involve two referral teaching hospitals. The analysis is based on data collected at King Abdullah University Hospital and Jordan University Hospital at the National Poisoning Centre from January 2003 through May 2013. A total of 221 cases were reported. At the NPC, carbon monoxide gas exposure was the leading cause of poisoning which accounted for 81.5% of the cases while unknown gases and unidentified vapours accounted for 18.5% of the toxicities. While the majorities (192 cases) of the reported cases were unintentional (88%) in the remainder, CO gas poisoning was used as homicidal in males and was used as a suicidal agent in females. At KAUH, all of the reported cases were unintentional. The findings demonstrate the incidence of CO poisoning in Jordan. To help lower the incidence of CO gas poisoning, policies should be structured to allow emergency departments to manage in accordance with international guidelines. Public education plays a key and significant role. Carbon monoxide poisoning can potentially be a significant invisible killer.

Key words: Carbon monoxide, poisoning, emergency, policies, education, Jordan

INTRODUCTION

Carbon monoxide gas is considered an odourless, flavourless, colourless and non-irritating gas that forms by incomplete combustion of organic and carbonaceous material due to insufficient O_2 (Horner, 2000; Prockop and Chichkova, 2007). The reported concentration of CO gas in the ambient atmosphere is <0.001% and potentially higher in contained environment (Ernst and Zibrak, 1998). Carbon monoxide has substantially more affinity to bind to haemoglobin within the red blood cells when compared with oxygen causing adverse effects in humans by combining with haemoglobin to form carboxyhemoglobin in the blood thus interfering with oxygen availability and delivery needed for cellular metabolism leading to tissue hypoxia particularly affecting the function of major organ such as brain and heart (Henry *et al*., 2006).

Carbon monoxide poisoning usually results from inhaling smokes and fumes from incomplete burning of natural gas or material containing carbon such as gasoline, butane, kerosene, oil, propane, coal or wood and less commonly from inhaling methylene chloride (Kao and Nanagas, 2004; Mahmud and Kales, 1999). The severity of clinical manifestation and short or long-term comorbidity is associated with severity of exposure and potentially other factors such as status of ventilation, health status, smoking habits and alcohol status, sex and age (Bernas *et al*., 2012; Huijun *et al*., 2016; Karapirli *et al*., 2013). Myocardial injury and neurological complications occurs frequently in patients exposed to moderate or severe CO poisoning and is a significant predictor of mortality (Henry *et al*., 2006; Pepe *et al*., 2011). The most commonly reported clinical signs and complaint

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associated with CO gas poisoning include weakness, dizziness and confusion, shortness of breath, drowsiness, chest pain, rales and rhonchi and seizure (Cardiga *et al*., 2015; Kao and Nanagas, 2004; Prockop and Chichkova, 2007). The permissible exposure limits according to the Occupational Safety and Health Administration (OSHA) is 50 parts of gas per million of air (mg m^{-3}). The OSHA standards prohibit worker exposure to more than 50 of the gas per million parts of air ppm during 8 h period. Exposure to more than 100 (ppm) is reportedly can endanger health and wellbeing of humans. Severe CO gas exposures may lead to significant toxicity of the central nervous system, heart and potentially death (Cardiga *et al*., 2015; Huijun *et al*., 2016; Kaya *et al*., 2016; Kuroda *et al*., 2016).

The incidence rate and epidemiology associated with CO gas exposure and poisoning is unknown in Jordan particularly at routine clinical practices and at referral centres. Carbon monoxide gas poisoning is a commonly overlooked or misdiagnosed type of intoxication and may present substantial diagnostic and treatment challenge. The physical characteristics of carbon monoxide, being odourless flavourless colourless and non-irritating, makes it very challenging to detect or suspect CO exposure. Researchers have recognized that the prevalence of post mortem diagnosis of CO gas poisoning is much higher when compared with clinical diagnosis (Ragheb and Battah, 1999). In here, the main aim of the study presented here is to report on the presentation of patients in the emergency department with potentially suspected CO poisoning and the management process based on symptoms.

MATERIALS AND METHODS

This is a retrospective study conducted at two referral teaching centres: King Abdullah University Hospital (KAUH) at Jordan University of Science and Technology and the other centre is at the National Poisoning Centre (NPC) at Jordan University Hospital (JUH). Medical records were obtained from the database during the period 2003 through 2013.

Data collection: At both the KAUH and NPC, patient's data were recorded in the data base. The following data were obtained from medical records of enrolled cases at the NPC: age, gender, nationality, geographical location, clinical signs, Glasgow Coma Score, arterial blood gas analysis, time of presentation to emergency department, management, clinical outcome and selected laboratory findings. While at KAUH, the following data were only obtained: age, gender, location where CO gas exposure occurred, intent of exposure (unintentional vs suicidal), clinical management and type of treatments, day and time of presentation.

Data analysis: The American Association of Poison Control Centres (AAPCC) has categorized the clinical outcome or effect associated with CO gas poisoning into different classes: "no effect", "minor effect", "moderate effect", "severe effect" and "death effect". The "no effect" category represents patients presented with no clinical signs and symptoms. The "minor effect" category represents patients that exhibit a certain degree of signs and symptoms after exposure however, they ought to be promptly evaluated and addressed. Unlike "minor effect", the "moderate effect" category represents patients that exhibit distinct prolonged and generalized signs. The "severe effect" category represents patients that present with acute signs that lead to a significant residual disability or deformity. The "death effect" category may result from exposure or from complications. In the study presented here, the clinical outcome was categorized based on the presenting clinical signs reported by attending emergency physician. Categories of exposure were categorized into three main parts including household poisonous products, gases (CO) and unidentified products. In addition, intent of exposure was categorized into unintentional, homicidal and suspected suicidal reasons.

RESULTS AND DISCUSSION

A total of 221 enquirers were received at both KAUH and NPC. The National Poison Centre at Jordan University Hospital received 92 enquirers while King Abdullah University Hospital received 129 inquires.

Out of the 92 enquirers from the NPC, 42 were females and 50 were males. Only 6/92 cases were referred from private local hospitals. Mean age for females was 28.11±14.98 years while mean age for males was 22.88±18.25 years. At the NPC, 85.9% of the locations where the exposure reported occurred at the patient's residence while 14.1% occurred outdoor, work and school. Carbon monoxide gas exposure was the leading cause of poisoning which accounted for 81.5% of the cases while unknown gases and unidentified vapours accounted for 18.5% of the toxicities. While the majority of the reported cases were unintentional (88%), 12% were considered intentional 4 of which (12%) were considered homicidal. While all reported homicidal cases were reported among male patients, 6 of the enquirers were considered suicidal which reported among female patients only. At the NPC,

the analysis of the clinical outcome revealed that 8.7% of the enquirers showed "no effect", 37% of the inquires showed "minor effect", 45.7% of the enquirers showed "moderate effect", 5.4% of the enquirers showed "severe effect" and two actualities were reported with an overall mortality rate of 2.2%.

Out of 121 enquirers reported at KAUH, 71 were females and 50 were males. Mean age for females was 24.46±13.61 years while mean age for males was 27.46±16.50. All enquirers reported unintentional. No homicidal or suicidal attempts using CO exposure were reported at KAUH.

Collectively, the most commonly reported clinical sign including dizziness in 17.87% of patients. The second most commonly reported sign was shortness of breath in 16.90% of the patients. Other reported complaints included vomiting in 14.49% of the patients, headache in 15.94% of patients, decreased level of consciousness in 11.11%, coughing in 6.76% of the patients, ocular irritation or increased lacrimation in 1.93% of the patients, dyspnoea in 1.93% of the patients, abdominal pain in 0.48% of the patients, chest pain in 3.38% of the patients and seizure in 0.48% of the patients.

Data about patients poisoning with carbon monoxide gas from two referral centres in Jordan were integrated to realize the aims of this study. Results showed that there is an increased use of management therapy with oxygen mask as a widely utilized. Till today, optimum treatment of CO poisoning is still controversial. General consensus of treatment of CO poisoning include moving the victim into fresh ventilated area and administering 100% oxygen through tight-fit mask (Rosenthal, 2006). Clinical outcome using hyperbaric oxygen therapy is still controversial and require standard protocol (Byrne *et al*., 2012). Just recently, Fan *et al*. (2016) have suggested a novel therapy using lactulose for acute CO poisoning. Lactulose has been suggested to ameliorate oxidative stress associated with CO poisoning by increasing intestinal hydrogen production.

At the time of data collection in 2004, Jordan had a population of approximately 5.4 million while in 2015 the population was estimated to be 9.53 million. Hospitals have tried to ensure management of CO gas poisoning, however with the increasing population there are relatively many more cases of CO poisoning when compared with developed and developing nations.

In the present study, physicians have reported 221 cases during the study period. This prevalence rate may be underestimated because only cases that needed management and support were reported or referred to hospitals. For instance, reporting cases with minor or unknown clinical outcome were delayed until after hospitalization in 1.1% of the cases. As in many other nations, reporting to national poisoning centre in voluntary and vastly depends on the severity of clinical manifestations. This is a debatable aspect where policy makers and regulatory bodies are to enforce laws and protocols to ensure better safety and quality assurance. At the moment, the Nation Poisoning Centre is aiming at implementing educational initiatives, purposely formulated by physicians to paramedics, first responders, general medical practitioners and other hospitals within Jordan to improve outcome and lower morbidity and mortality rates associated with CO poisoning.

In here, the documented clinical signs and symptoms are comparable to reported signs (Icme *et al*., 2014; Yurtseven *et al*., 2015). Symptoms may vary among individuals and clinical manifestation may occur sooner in young or geriatric patients and in those with history of cardiopulmonary diseases, people with smoking habits or people living at higher altitude (Bernas *et al*., 2012; Henry *et al*., 2006). In here, the most two commonly reported clinical signs are dizziness and shortness of breath.

In the study reported here carbon monoxide poisoning was prevalent (81.5% of exposures), an aspect that potentially validated the large scale use of oil, charcoal heaters, kerosene heaters in unventilated areas, wood stove heaters with the lack of proper infrastructure built to overcome and avoid the risk of exposure to CO gas during winter seasons in Jordan. More recently, citizens have widely started using olive mill By-products known as "Jift" for heating purposes due to substantially lower cost when compared with gas, kerosene and other forms of heating (Abu-Ekteish, 2002). Local statistics suggest that there are more people diagnosed with CO poisoning secondary to unsafe usage of "Jift" for heating purposes particularly in rural areas. In here, many of the reported unintentional CO gas poisoning is vastly due to smoke inhalation. In Jordan, the most commonly incriminated possible source of CO are poorly ventilated wood or "Jift" stoves in addition to kerosene portable heaters and gasoline generators.

In the study presented here, exposure patterns in regard to gender do not appear substantial. The CO poisoning was a little more common in male when compared with females which could be explained by the larger number of males when compared to females according to data obtained about 2006 Jordan population census. Just recently, it has been demonstrated that females may have an advantage over males in regard to severity of poisoning and prognosis (Henry *et al*., 2006).

Numerous functions and tasks are undertaken by the NPC to implement its most important mission of precluding unintentional carbon monoxide poisoning. The NPC provides the most updated and current standards and protocols to health care providers particularly emergency physicians and first time responders. In here, regulatory bodies play a critical role to ensure and facilitate the NPC role. In here, researchers have recognized that there is disparity in the type of information and data provided by the two centres which reflect the need of cooperation among all hospitals and staff to provide adequate and consistent information and data. International integration of the NPC is critical (Laborde, 2004). The IPCS INTOX Program is a global effort to promote chemical safety by establishing and promoting poison centres through international cooperative and collaborative efforts. Among the major activities of the IPCS INTOX is to promote consistent and harmonized data collection, development training manuals and ultimately to maintain a network to share information and mutual assistance among centres.

CONCLUSION

The prevention of CO gas poisoning is a significant public health issue. Domestic carbon monoxide poisoning can be prevented by early detection with the use of carbon monoxide detectors in houses and at industrial locations. In addition, surveillance of people most at-risk for unintentional CO gas poisoning is substantial to prevent or mitigate incidence rate of CO gas poisoning. For instance, Occupational Safety and Health Administration (OSHA) have list some of at-risk population including welders, garage mechanic, firefighter, diesel engine operator, forklift operator, toll booth or tunnel attendant, police officer and taxi driver.

The study presented here the CO poisoning in two canters in Jordan. Although, there is no detailed standards that help guide management of CO poisoning, there is a need to establish a structured protocol not just for CO poisoning but also for other incidental poisoning. Previous study conducted in Jordan to characterize poisoning patterns revealed that the most commonly incriminated causes of poisoning include drugs with acetaminophen products were responsible for most of the cases within this category (Obaidat *et al*., 2010). In a study conducted to characterize the fatalities in Jordan associated with poisons, CO poisoning accounted for 1.8% of the causes of deaths over the 5 years (Battah *et al*., 2009).

LIMITATIONS

Limitations of the study reported here are many including disparity in the data gathered at the two canters. The blood gas analysis, methaemoglobin and carboxyhaemoglobin were only reported at one center and only in small number of cases where the analysis was less meaningful.

SUGGESTION

Just recently, there is evidence that CO poisoning may induce thermochemical injury of respiratory tract thus inducing severe acid-base imbalance which suggest the need of performing blood gas analysis in all suspected cases having CO poisoning (Polozova *et al*., 2015).

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