Original Article

Pathology of Deaths from Carbon Monoxide Poisoning in Port Harcourt: An Autopsy Study of 75 Cases.

Seleye-Fubara D., *MBBChir, FMCPath, FWACP, FICS*
Etebu E. N., *MD, FMCPath, FICS,*
Athanasius B., *MBBChir*
Departments of Anatomical Pathology, University of Port Harcourt Teaching Hospital PMB 6173, Port Harcourt, Nigeria.

ABSTRACT

BACKGROUND: Carbon monoxide (CO) poisoning is a notable cause of death at homes and industries that is posing public health problem worldwide that requires an elaborate study.

OBJECTIVE: To study and characterize deaths resulting from the noxious gas (CO).

DESIGN: A ten year (January 1st, 1995 December 31st 2004) autopsy study.

SETTING: Port Harcourt, Nigeria.

METHODOLOGY: Coroners and hospital autopsies performed by the authors at the University of Port Harcourt Teaching Hospital (UPTH), other hospitals and private mortuaries in Port Harcourt on deaths from carbon monoxide poisoning were studied over ten years. The circumstances of death reported by police were accidental, homicidal or suicidal; and other autopsy findings were used for the study.

RESULTS: A total of seventy five autopsies were studied; out which 21(28.0%) were females and 54(72.0%) males giving a ratio 1:2.6 male dominance. The highest frequency of death 25(33.3%) occurred in the age group 60 69 years; while the least 3(4%) occurred in the age group 0 9 years. The youngest was an unborn 7 month old male fetus while the eldest was 85 years old female. The most common was accidental carbon monoxide poisoning which accounted for 48(64%) cases. While Homicidal CO poisoning was 24(32%) and suicidal CO poisoning was 3(4.0%). Body recovered from fumy electric generator rooms was 46(61.3%) while least frequency was bodies recovered from naked flame 3(4%).

CONCLUSION: Carbon monoxide poisoning is posing a serious public health problem when ever it occurs. There is need for public enlightenment about this gas as it is related to fumes from generator, car exhausts, poorly ventilated rooms and enclosed chambers in order to reduce the carnage associated with it both at home and industries.

KEY WORDS: Carbon monoxide, poisoning, death, Port Harcourt.

INTRODUCTION

Carbon monoxide (CO) is a colorless, odorless, tasteless and toxic gas which accumulates in poorly ventilated rooms[1]. It is one of the most common toxic conditions the Forensic Pathologist encounters in his practice. This condition also constituted more than 50% of fatal poisoning in many industrialized countries of the world.[1] In USA, about 200 people die each year from carbon monoxide poisoning associated with home fuel-burning and heating equipments alone.[2,3] In UK, it is known to be the most common cause of death by poisoning[3,4] while in France and China, the gas is responsible for the death of 200 3000 and 420,000 people annually respectively.[3-5]

It is produced where ever fossil fuels (gas and oil), coal, wood burning, engine exhaust, furnaces, ice resurfacer and where open fire are incompletely oxidized to carbon dioxide (Co_2)[1,6,8]. It is a common domestic and industrial hazard that does not spare the fetus of an affected pregnant woman where it causes instant death and neurological abnormality should the fetus survive to term[1,3,9]. It also damage the brain and the heart of other victims due to hypoxia.[1,3,10] Carbon monoxide binds with myoglobin, hemoglobin and mitochondrial cytochrome oxidase, compromising their cellular activity in the human body which results in death of the victim[1,3,11-13]

Being unaware of similar study in this setting, this study sets out to elucidate the pattern of death from this noxious gas and to suggest public awareness campaign aimed at preventing the incidence reducing morbidity and mortality, and to include our findings in the literature.

MATERIALS AND METHOD

A study of medicolegal autopsies performed by the authors in Port Harcourt metropolis and environs from 1st January 1995 to December 31st 2004, in which the circumstances of death and autopsy findings fit into carbon monoxide poisoning was carried out. These autopsies were preceded by coroner's inquest forms, which were authorized by the judiciary and served through the police. Reports and death certificates were issued after every autopsy.

Variables considered include: the age, sex,

Correspondence: Dr. D. Seleye-Fubara
E-mail: dsfubara@yahoo.com

circumstances of death and mode the bodies were found. The data were collated, analyzed and tabulated to determine the frequency and the rate of these fatalities. The results were expressed in simple percentages.

RESULTS

Out of the 1,265 autopsies performed during the period under review, 75 (5.9%) were death from circumstances that fit into carbon monoxide poisoning giving an average of 7 to 8 per year. The youngest was a 7 month old male fetus (crown heel measurement of 35cm length). This gestational age was estimated using Haase's rule of thumb which states that, the square root of the crown-heel length of 25cm and below gives the age of the fetus in months whereas, above 25cm, the value is divided by 5 to give the age also in months[7]. The oldest was an 85 year old woman.

Table I shows the age and gender distribution of victims of carbon monoxide poisoning. The highest frequency occur in the age group 60 69 years 25(33.3%) then ages group 50 59 years which recorded 14(18.7%), while the least was in age group 0 9 that recorded 3(4.0%) cases. On the whole, more victims were found among males 54(72.0%) than females 21(28.0%) giving a sex ratio of 2.6:1.

Table 1:Distribution of age and sex of victims of carbon monoxide poisoning.

Ages in years	Sex		Total (%)
	Males	Females	
0 - 9	1	2	3(4.0)
10 - 19	4	1	5(6.7)
20 - 29	4	2	6(8.0)
30 - 39	7	1	8(10.7)
40 - 49	4	4	10(13.3)
50 - 59	12	2	14(18.7)
60 - 69	19	6	25(33.3)
70 and above	1	3	4(5.3)
TOTAL	**54(72.0%)**	**21(28.0%)**	**75(100.0)**

Table II shows the distribution of circumstance of carbon monoxide poisoning. Majority 48(64%) cases were accidental, 24(32%) homicidal and 3(4.0%) suicidal carbon monoxide poisoning.

Table II: Distribution of circumstances of carbon monoxide poisoning.

Circumstances of carbon monoxide poisoning	Number	(%)
Accidental poisoning	48	(64.0)
Homicidal poisoning	24	(32.0)
Suicidal poisoning	3	(4.0)
Total	**75**	**(100.0)**

Table III shows the frequency distribution of the mode bodies were recovered for autopsy. Forty six (61.4%) cases died from fumes from generator exhaust, 20(26.7%) cases died from smoky room, 6(8.0%) cases were recovered from car garage while 3(4%) were recovered from naked flame.

Table III: Frequency distribution of mode the bodies were found at autopsy.

Mode bodies were found	Number	(%)
Bodies recovered from fumy generator rooms	46	(61.3)
Bodies recovered from smoky room	20	(26.7)
Bodies recovered from car garage	6	(8.0)
Bodies recovered from naked flame	3	(4.0)
Total	**75**	**(100.0)**

DISCUSSION

Carbon monoxide poisoning is threatening to be a public health problem in Nigeria largely due to ignorance and the fact that, the fumes are not easily detected by the human senses.[1] Death occurs after the inhalation of the gas which accumulates in blood to about 40%[15]. The scenario is even worst in old and debilitated victims where values as low as 25% may cause death.[15] This is corroborated by our study which recorded the highest frequency of death (33.3%) at the age range of 60 69 years. The reason may be attributed to the decreasing cardiac, central nervous and respiratory reserve making them more vulnerable to carbon monoxide poisoning; mirroring the pattern in another study.[16] It is therefore imperative that, carbon monoxide poisoning may be aggravated in victims having pre-existing central nervous, respiratory and cardiac diseases.

At the other extreme age groups (0 9 years) carbon monoxide poisoning is more fatal. For instance, this study recorded a pregnant woman who was rescued from an inferno and resuscitated, later had a still birth. Autopsy finding in the 35cm crown heel length fetus (7 months old) was suggestive of carbon monoxide poisoning as the nail-bed, blood and some muscles were cherry-pink in color which was similar to that reported elsewhere.[1] Therefore, the effect of carbon monoxide on the fetus is of great consequence while the mother suffered minor deleterious effect. The reason may be attributed to the combination of carbon monoxide with hemoglobin to form carboxy hemoglobin which causes fetal tissue hypoxemia by decreasing the release of maternal oxygen to the fetus. Also, carbon monoxide cross the placenta and combined with the fetal hemoglobin which has 10 -15 times higher affinity for carbon monoxide than the adult hemoglobin.[1] Again, the rate of eliminating carbon monoxide by the fetus is slower; leading to the accumulation of the gas in the fetal blood. There is a male dominance in the death tool from carbon monoxide poisoning in this study which is contrary to the findings in other studies[17-19]. The reason for this disparity is unclear.

Accidental death from carbon monoxide poisoning constituted 64% cases in this communication. The accident occurred when carbon monoxide is inhaled from fumes produced by gasoline generators which were ignorantly placed in the sitting rooms and/or

confined spaces for safety especially at night and rainy days.[8] Death is even more frequent with gasoline fueled generators than diesel engines corroborating the report of another study[20]. In other cases of conflagration, the carbon monoxide depresses the central nervous system making them feel tired, have head ache, dull vision, confusion, giddiness and irritable[21]. The unconsciousness may be attributed to cerebral anoxia caused by the inhalation of carbon monoxide. In the respiratory system the carbon monoxide gas causes thermal damage to the air passage and lungs. It also produces pneumonia, pulmonary edema, and respiratory arrest[16]. In the heart, it causes myocardial necrosis due to tissue hypoxemia which is in keeping with other studies, leading to death[10,16].

Studies have shown that, slow smoldering fire with little flame are likely to produce more carbon monoxide because of limited access to oxygen or the exhaustion of the available oxygen during the combustion[8,15]. This study also believed that, the immediate cause of death in fire accident is carbon monoxide poisoning long before the flame reaches the body. Another notable accidental death from carbon monoxide poisoning concern those who intentionally inhale fumes from gasoline generator to produce partial cerebral anoxia to accentuate the sensation of an abnormal sexual practice.[15] This however was not recorded by our study. This act actually is extremely dangerous, but since the intention was not suicidal, it has to be classified as accidental.

Homicidal death from carbon monoxide was recorded in 32% of cases. The circumstance of death in these cases was suggestive of homicide since the houses were intentionally set ablaze by the assailant. This circumstance of death actually involved eighteen people (24%) in four different occasions and in 8% cases the victims were intentionally roasted alive by militant youths in search of their opponents. In this instance death may be due to carbon monoxide inhalation before the direct heat of the flame.

Suicide by carbon monoxide poisoning is an incidental finding involving only 4% of our cases. The autopsy findings in either case were similar to that of accidental and homicidal CO associated deaths. For instance these cases were seen in a private poorly ventilated garage on two different rainy days. It may be possible that, these men (night watchmen) ignorantly took shelter in the steaming generator rooms thereby poisoning themselves. Suicidal deaths by CO poisoning among blacks are rare when compared to whites[18,19]. This rarity was reflected by the 4% recorded in this study.

This study also recorded locations where the bodies were recovered for autopsy. Majority (61.3%) of the bodies were recovered from poorly ventilated generator rooms where the victims ignorantly took shelter and died where as 4% of our cases were recovered from poorly ventilated motor garage. In three different occasions, carbon monoxide poisoning sniffed off the lives of the entire family as they were exposed to fumes from gasoline generators which were found in their sitting rooms the following day. Majority of the generator related CO poisons occur with petrol generators which are commonly used because a petrol engine produces more carbon monoxide when compared to diesel engines[16]. We also noticed that, not all the victims that inhaled the same quantity of carbon monoxide died at the same time in a particular incident. The reason may be attributed to one having pre-existing disease that may accelerate the effect of the carbon monoxide; the quantity of the gas inhaled and the length of exposure to the gas. The presence of carbon monoxide in the blood indicates that the victims was alive after the fire began; meaning that, the inhalation of carbon monoxide is not likely after death as was indicated in one study[16].

The diagnosis/proof of carbon monoxide poison in a body at autopsy apart from the aforementioned cherry-pink coloration in different parts of the body is by **reversion spectroscopic examination** of the blood of the victim. The spectroscopic examination was however not done in this study. The study also noticed in two cases where the cherry-pink coloration was absent and these victims were either very anemic and/or pigmented. It may also be misdiagnosed in bodies embalmed with solutions containing eosin for the purpose of retaining the color of fair individuals because eosin also imparts cherry-pink coloration to muscle tissue.

In conclusion, carbon monoxide poison poses a lot of problems to the people as the entire family may be wiped out by this noxious gas. There is therefore need for public enlightenment about the dangerous nature of the gas vis a vis measures to reduce deaths caused by it.

REFERENCES

1. Omaye ST. Metabolic modulation of carbon monoxide toxicity. Toxicology 2002; 180: 139-150.
2. Weaver LK, Deru K. Carbon monoxide poisoning at motels, hotels and resorts. Am J Prev Med 2007; 33: 23- 27.
3. Iribhogbe PE, Erah FO. Carbon monoxide poisoning in Nigeria. It is time to pay attention. PH Med 2009: 4: 88- 91.
4. Clarke SF, Crosby A, Kumard D. Early carbon monoxide intoxication: Happy to be poisoned? Emerg Med J 2005; 22: 754-755.
5. Zhang JJ, Smith KR. House hold air pollution from coal and biomass fuels in China: Measurement, health impacts and interventions. Environ Health Perspect 2007; 115: 848-855.
6. Buckley NA, Isbister GK, Stokes B, Juulink DN Hyperbaric oxygen for carbon monoxide poisoning

a systematic review and critical analysis of the evidence. Toxicol Rev 2005; 24: 75- 92.
7. Fawcett T, Moon R, Fracica P, Mebane G, Theil D, Piantadosi C. Ware house workers head ache carbon monoxide poisoning from propane fueled forklift. J Occup Med 1992; 34: 12-15.
8. Cukor J, Restuccia M. Carbon monoxide poisoning during natural disaster: the Hurricane Rita experience. J Emerg Med 2007; 33: 261-264.
9. Alehan F, Erol I, Onay SO. Cerebral palsy due to non lethal maternal carbon monoxide intoxication. Birth Defects Res A clin Mol Teratol 2007; 79 : 614-616.
10. Prockop LD, Chichkova RI. Carbon monoxide intoxication: an updated review. J Neurol Sci 2007; 262 : 122-130.
11. John C, Moran J, Paine S, Anderson H, Breysse P. Abatement of toxic levels of carbon monoxide in seattle ice-skating rinks. Am J Public health 1975; 65: 1087 -1090.
12. Henry CR, Satran D, Lindgren B, Adkinson C, Nicholson CI, Henry TD. Myocardial injury and longterm mortality following moderate to severe carbon monoxide poisoning. JAMA 2006; 295: 398 - 402.
13. Alonso JR, Cardellach F, Lopez S, Casademont J, Miro O. Carbon monoxide specifically inhibits cytochrome oxidase of human mitochondrial respiratory chain. Pharmacol Toxicol 2003; 93: 142 - 146.
14. Seleye-Fubara D, Uzoigwe SA. Maternal mortality from ruptured Ectopic pregnancy in Rivers State Nigeria: Analysis of 38 autopsies performed in 12 years. Sahel Med J 2003; 6: 111
15. Simpson K. Gaseous and volatile poisons. In Keith Simpson's Forensic Medicine 8th Ed Edward Arnold London 1982; 340-361.
16. Choi IS. Carbon monoxide poisoning: Systemic manifestations and complications. J. Korean Med Sci 2001; 16: 253-261.
17. Seleye-Fubara D. Pathology of violent deaths in the Niger Delta Zone of Nigeria 1996 1999. A dissertation to West African College of physicians in part fulfillment for the Award of its fellowship. 2002; 16: 30-39.
18. Pinto C, Koelmeye TD, Self inflicted death in Auckland: A study of 105 cases. N Zealand Med J 1991; 104: 88-89,
19. Dudley M, Waters B, Belk W, Howard J. Youth Suicide in New South Wales. Urban rural trend. Med J. Australia 1992; 156: 83-88.
20. Knight B. Carbon monoxide poisoning. In Forensic Pathology 2nd Ed Edward Arnold London 1992: 505-510.
21. Ilano AL, Raffin TA. Management of Carbon Monoxide poisoning. Chest 1990. 97; 165-169.