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RESEARCH

Knowledge and attitude of Nigerian personnel working at Federal Medical Centre in Nigeria on carbon monoxide poisoning from electrical power generators

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Background: Private portable electrical power generators are common household items in Nigeria owing to inadequate electrical power provision for the public. These engines often run indoors, emitting poisonous carbon monoxide gas. Fatalities are commonly reported as a result of carbon monoxide inhalation. This study evaluated awareness of and attitudes towards the dangers of carbon monoxide poisoning in health personnel in a Nigerian referral hospital.
Method: The study was carried out on personnel working at the Federal Medical Centre, Owo, Nigeria. The respondents were interviewed using a self-administered, semi-structured questionnaire. The obtained data were collated and analysed with SPSS®, version 16.
Results: One hundred and seventy-six health workers participated, and 157 completed and returned the survey questionnaire (89.2% response rate). Of these, 95 respondents (60.5%) were informed about carbon monoxide poisoning and 62 (39.5%) were not. Moreover, 105 respondents (73.4%) had no idea of sources of carbon monoxide poisoning. Twenty-three of the 95 informed respondents (24.2%) had received information on carbon monoxide poisoning through the newspaper. Sixty-two respondents (39.5%) indicated that they preferred to run electrical generators indoors, and 89 (56.7%) could not recognise the physical properties of carbon monoxide. Potential damage by rain (72, 53.3%), and fear of theft (38, 24.8%) and destruction of the generators by children (14, 10.4%) were the supplied reasons for running generators indoors.
Conclusion: The health-related dangers of carbon monoxide poisoning as a result of operating electrical generators indoors were poorly appreciated, even by health workers. There is a need for wider public education on the subject in Nigeria, and especially in the mass media and at schools and hospitals.

Keywords: awareness, carbon monoxide poisoning, electrical power generator

Introduction

There are frequent mass casualty reports in the Nigerian mass media on carbon monoxide poisoning from electrical power generators. This indicates that this is a serious health risk, and deserving of the attention of public health professionals.[1,2] Like many other African countries, there is limited access to modern energy services in Nigeria. Despite the fact that energy is instrumental to socio-economic development and poverty alleviation, presently, 60–70% or approximately 80 million Nigerians do not have access to electricity.[3] Owing to the constant lack of a reliable electrical supply from the national power grid in Nigeria, many people and business concerns have resorted to augmenting power generation using their own electrical power generators at high cost to themselves and to the Nigerian economy.[3] Power generators emit noxious carbon monoxide when operated from within an enclosure.

Carbon monoxide is a colourless, odourless, non-irritating, but poisonous gas, produced by the incomplete combustion of hydrocarbon in gasoline engines used to power several home appliances.[2] Carbon monoxide is found in combustion fumes produced by cars, trucks, electrical power generators, stoves, lanterns, and when burning charcoal and wood. Carbon monoxide is produced when there is a poor supply of atmospheric oxygen from the air, needed to complete the hydrocarbon combustion process in respect of these fuels. It can rapidly build to a dangerous concentration level, especially in enclosed or semi-enclosed spaces.[4]

Carbon monoxide is known to be a silent killer, since it is colourless, odourless and poisonous.[2] Each year in Britain, approximately 50 people reportedly die and 200 suffer severe morbidity by carbon monoxide poisoning.[5] Some poisoning is caused by intentional harm, but most of it is accidental.[6] It is the most common cause of accidental poisoning, and according to one estimate, carbon monoxide poisoning symptoms in as many as 25 000 people in the UK can be attributed to faulty gas appliances.[5] Between 1999 and 2004, 400 Americans died annually from unintentional carbon monoxide poisoning. Twenty thousand presented at the emergency room, and 4 000 were hospitalised owing to carbon monoxide poisoning. The national annual death rate was 1.5 per million persons.[7] Fatality is highest in Americans aged 65 years and older.[7] Fires in non-ventilated shelters were an age-long source of carbon monoxide in ancient times.[2] In 1857, Claude Bernand described carbon monoxide as being poisonous and dangerous as a result of its reversible displacement of oxygen from haemoglobin to form carboxyhaemoglobin.[2] Carbon monoxide from motor vehicle exhausts is the single most common cause of deaths by poisoning in the USA. Most vehicle-related carbon monoxide deaths in garages occur even when the garage doors or windows are wide open, suggesting that passive ventilation may not be enough to reduce the risk in semi-closed spaces.[1]

The true incidence of lethal or non-lethal carbon monoxide poisoning is not known in Nigeria. Carbon monoxide poisoning is often misdiagnosed as food poisoning, viral illness and gastroenteritis. Owing to this, a high index of suspicion is needed by personnel in the emergency unit of various hospitals in order to appropriately diagnose the illness, especially when a similar illness occurs simultaneously in two or more persons or pets.[8] The most common symptoms of carbon monoxide poisoning include headaches, dizziness, weakness, convulsions, seizures, confusion, chest pain, vomiting, diarrhoea, coma or even death.[6-12]

Method

This study was carried out on health workers, excluding nurses, doctors and pharmacists, attending a clinical presentation by the Federal Medical Centre in the hospital's main auditorium. Prior to commencement of the study, ethical clearance was obtained from the centre's health research ethics committee. Modification of the questionnaire used by Ntaji et al[13] in a similar study in Nigeria was used in this survey. The questionnaire was re-designed to incorporate the aim and objective of this study.

The survey was carried out using a self-administered, semi-structured questionnaire. The respondents were interviewed by the authors of this study, alongside trained research assistants. Information on awareness of and attitudes towards the dangers of carbon monoxide were subsequently obtained using a semi-structured questionnaire. The data obtained from respondents were assessed, and included demographic information, attitudes towards carbon monoxide poisoning, knowledge of its dangers, the prevention thereof and signs of presentation from poisoning, were assessed. Other data included knowledge of the sources of carbon monoxide pollution and poisoning. The data were collated and analysed using SPSS® 16.0.1 statistical software. Cross-tabulation was carried out.

Results

One hundred and fifty-seven respondents participated in this study. They comprised 93 males (59.2%) and 64 females (40.8%). Their ages ranged between 21 and 60 years, with a mean age of 39.8 (± 9.5) years. The majority of respondents (127, 80.8%) were married. Twenty-eight (17.8%) were single and the remaining two (1.3%) divorced.

Most of respondents (126, 80.3%) were Christians, and the rest were Muslim. The majority of the respondents (111, 70.7%) were of Yoruba extraction, and the remaining 46 (29.3%) other ethnic groups. Half of the respondents (79, 50.3%) had received a tertiary education, 47 (29.9%) a secondary education, and the remaining respondents (31, 19.7%), a primary education.

The majority of respondents (110, 80.1%), were in service for over five years. Ninety-eight (62.4%) had positioned and switched on electrical power generators in their homes at least once in the last one year, while the remaining respondents (59, 37.6%) had not. Some of the respondents (37, 23.6%) worked in the surgical section of the hospital (Table 1). This section included workers in the surgical outpatient department, surgical wards, operating theatres and surgery departmental offices.

Table 2 shows that 95 (60.5%) of respondents had received information on the dangers of carbon monoxide poisoning, while the remaining 62 (39.5%) had not done so. Approximately a quarter of the respondents 23 (24.2%) received information on carbon monoxide poisoning through the newspaper (Table 2).

According to the results detailed in Table 3, 24 respondents (30.4%) knew that electrical power generators were a source of carbon monoxide poisoning. Approximately half of the respondents (49.7%) were unaware of this.

Of the respondents, 71 (41.2%) were aware of at least one symptom of carbon monoxide poisoning in a patient, while 86 (58.8%) had no idea. As shown in Table 4, headaches were the most frequently identified symptom in patients with carbon monoxide poisoning. Other identified symptoms are detailed in Table 4.

Table 5 shows that 62 (39.5%) of the respondents believed that a working electrical power generator should be put indoors. Eighty-nine (56.7%) were unable to recognise the physical properties of carbon monoxide.

Potential damage by rain (72, 53.3%), and fear of theft (38, 24.8%) and destruction by children (14, 10.4%) were the three

Table 1: Respondents' work stations within the hospital

Section	Frequency	Percentage
Surgery	37	23.6
Internal medicine	29	18.5
Administration	22	14
Medical records	18	11.5
Continuous education	18	11.5
Works and services	17	10.8
Physiotherapy	5	3.2
Diet therapy	5	3.2
Accounts	4	2.5
Medical social workers	2	1.2
Total	157	100

Table 2: Information sources on carbon monoxide poisoning

Source	Frequency	Percentage
Newspaper	23	24.2
Hospital	20	21.1
Television	19	20
Radio	9	9.5
Spouse	9	9.5
Neighbour	7	7.4
Friend	4	4.2
School	2	2.1
Internet	1	1.1
Social media	1	1.1
None	62	39.5
Total	157	100

Table 3: Respondents' knowledge of carbon monoxide as a source of poisoning in Nigeria

Source	Frequency	Percentage
Power generator	24	15.3
Car exhaust	21	13.4
Kerosene stove	20	12.7
Kerosene lantern	10	6.4
Gas cooker	2	1.3
Motorcycle exhaust	2	1.3
None	78	49.7
Total	157	100

most frequent reasons for placing working generator indoors (Table 6).

Discussion

The respondents' mean age was a reflection of their active service. Most respondents were of Yoruba extraction. This was not unusual as the study was carried out in a community dominated by the Yoruba ethnic group in the south-western part of Nigeria. A preponderant proportion of the respondents had been in health service for over five years. It is expected that health workers are a key source of information on public health concerns.[1] Therefore, the study population in this survey should have been more aware of sources and dangers of carbon monoxide pollution and poisoning than average Nigerians. This is why it is remarkable that approximately 40% of the surveyed population considered it acceptable to place a working electrical power generator indoors. Nearly an equal proportion (37.9%) had no views on the subject. This is despite the fact that healthcare workers are presumed to have above-average literacy and greater access to health information than the general populace.

Table 4: Respondents' knowledge of the symptoms of carbon monoxide poisoning

Source	Frequency	Percentage
Headaches	21	13.4
Dizziness	19	12.1
Convulsions	14	19.7
Difficulty breathing	6	8.9
Unconsciousness	5	3.2
Weakness	4	2.5
Death	2	1.3
None	86	1.3
Total	157	100

The Power Holding Company of Nigeria (PHCN) is the statutory sole provider of electrical power in the country. Total installed electricity capacity is reported to be approximately 5 900 megawatts annually, while South Africa's capacity (with a quarter of the population of Nigeria) was roughly 44 000 megawatts, according to a 2010 report.[13] The gross inadequacy of the public-provided electrical power service was indicated by the fact that all of the members of the studied population had purchased electrical generators of varying capacity. PHCN resorts to regular power outages, accompanied by incessant power failure. The pervasiveness of electrical generators in Nigerian households is not matched by knowledge and information on the health-related dangers of operating generators indoors. This is a major failure with respect of public health and social information.

It is noteworthy that whereas the Nigerian media barely informs the public on the health-related dangers of carbon monoxide poisoning that arises from running an electrical generator indoors, it is replete with news of deaths and illnesses resulting from such phenomenon. Ntaji et al[13] reported that hardly a month went by without one or more Nigerian newspaper reports of death attributed to carbon monoxide poisoning. In another study, Iribhogbe and Erah[14] admonished Nigerian local media to do more in educating the public about the risks of carbon monoxide poisoning.

Recognising patients with carbon monoxide poisoning is a Herculean task for the masses, and also poses a major challenge to healthcare givers worldwide.[2] The difficulty in diagnosing this condition is attributable to the fact that its initial symptoms are vague. Mild symptoms of carbon monoxide poisoning include headaches, nausea, vomiting, dizziness and weakness. Convulsions, unconsciousness and death are more severe symptoms. Carbon monoxide poisoning is aptly named "the disease of many faces" because its diagnosis often eludes

Table 5: Respondents' attitudes to generators and carbon monoxide

Attitudes on	Agree, *n* (%)	Disagree, *n* (%)	Don't know, *n* (%)
Placing a working generator in the house	62 (39.5)	37 (23.6)	58 (37.9)
Placing a working generator outside	49 (31.2)	51 (32.5)	57 (36.3)
Placing a working generator anywhere	46 (29.3)	23 (14.6)	88 (56.1)
Generators produce carbon monoxide in the house	34 (21.7)	49 (31.2)	83 (52.9)
Generators produce carbon monoxide outside	55 (35)	51 (32.5)	51 (32.5)
Generators produces hot fumes	157 (100)	0 (%)	0 (%)
Generators needs an adequate oxygen supply	45 (28.7)	17 (10.8)	95 (60.5)
Carbon monoxide can kill	56 (36.7)	15 (9.5)	86 (54.8)
Carbon monoxide has a pungent smell	11 (0.07%)	58 (36.9)	88 (56.1)
Carbon monoxide is dark in colour	20 (12.7)	48 (30.6)	89 (56.7)

Table 6: Respondents' reasons for placing the working generator indoors

Reason	Frequency	Percentage
Potential damage to the generator by rain	72	45.9
Fear of theft of the generator	38	24.2
Potential destruction of the generator by children	14	8.9
Preventing neighbours' discomfort	5	3.2
Having easy access to the generator	4	2.5
Being able to refuel the generator easily	2	1.3
None	22	14
Total	157	100

medical staff.[14] A high index of suspicion is required to track the disease in outpatients with mild symptoms, or those with severe symptoms who are admitted to the intensive care unit of tertiary hospitals, especially when several members of a family or their pets are affected. Analysis of a heparinised arterial or venous blood sample for carboxyhaemoglobin concentration can aid diagnosis.[15]

This study demonstrated poor recognition of the signs and symptoms of carbon monoxide poisoning by the respondents. While headaches were the most commonly reported carbon monoxide-associated symptom, only one respondent was aware that carbon monoxide poisoning could cause death. More than half (approximately 55%) of the respondents could not identify any symptoms of carbon monoxide poisoning. In their study in Nigeria, Ntaji et al[13] reported poor knowledge of the features of carbon monoxide poisoning among preclinical medical students studied. Another study by Pach et al[16] found similar results in a studied university student population. The results of the questionnaire research on carbon monoxide poisoning in students at State Higher Vocational School in Nowy Sacz (Institutes of Economy, Paedagogic, Technical and Health) were presented in their study. The mean age of the examined group was 22.7 ± 4.94 years, with female predominance (77.6%). The questionnaire covered demographic data and knowledge of carbon monoxide sources, exposure, the most frequent and severe symptoms and the most severe sequels, as well as risky behaviour and risk groups for carbon monoxide poisoning. The results indicated inadequate knowledge of carbon monoxide poisoning, even by the young student population.[16] Proper education and prophylaxis activity is necessary to avoid accidental carbon monoxide poisoning.[16] Thus, the need for appropriate public education and prophylactic measures against carbon monoxide poisoning is stressed.

The studies of Iribhogbe and Erah[14] and Seleye-Fubara et al[17] identified electrical power generators as the most common source of carbon monoxide poisoning. Operating electrical power generators outdoors does not pose a serious risk of carbon monoxide poisoning to individuals. Operating them indoors results in carbon monoxide poisoning. Unfortunately, only a quarter of all of the respondents (approximately 24.1%) understood that electrical generators must be operated outdoors. The problem may be compounded by the poor socio-economic housing situation in Nigeria, whereby an average of five people live in a room. This may greatly aggravate casualty figures in the event of a mishap.

The most common reasons for operating generators indoors included potential damage by rain, and the fear of theft and potential destruction of the machinery by children. Most of geographical Nigeria lies within the rainforest belt, including the area in this study. The exposure of electrical generators to rain is inimical to the good functioning thereof. This may explain why many of the respondents preferred to operate their generators indoors, thereby incurring the attendant danger. The risk of children tampering with dangerous household objects is universally acknowledged.[18-20] However, this should not be allowed to influence reasons for operating an electrical generator indoors.

Conclusion

The axiom that prevention is better than cure is very apt in the case of carbon monoxide pollution and poisoning arising from domestic generators. Public health personnel, the mass media and public and private agencies have a duty to educate the public on the safe operation of domestic and commercial appliances. Electrical generators must be operated outdoors in designated structures that are well ventilated and allow engine fumes to escape into the open atmosphere. Smoke (and carbon monoxide) alarm systems could be installed in homes and public buildings to detect the accumulation of toxic smoke and fumes. Although this study was designed to evaluate knowledge of and attitudes towards carbon monoxide poisoning by personnel working in a tertiary hospital, it is recommended that a study that ascertains how clinicians can effectively detect and treat a patient with suspected carbon monoxide poisoning should be carried out in the future.

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