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Investigation of Suspected Carbon monoxide Poisoning Outbreak in Akure, Ondo State, 2014

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Abstract

On 11th June, 2014, a cluster of deaths of unknown cause suspected to be food poisoning were reported in Oke Ogba, Akure South Local Government Area of Ondo State. We investigated to identify the source and to propose recommendations. A case was defined as a resident of the affected house that died or was hospitalized on 11th June, 2014.We line listed suspected cases and conducted environmental investigations. We collected and sent specimens of food for toxicology testing to identify a possible aetiological agent. Blood samples likewise underwent testing. Between 11th June and 28th June, 2014, 8 cases (5 children and 3 adults) were identified in the household (attack rate: 100%). Six deaths were recorded (case fatality: 75%). The case fatality rate was higher among children, 4 out of 5 (80%). More females (4/6, 67%) died than males. Food samples were not positive for any tested pathogen. There was evidence that an electricity generating set had been used prior to the incident. A walk through survey showed a poorly ventilated house with the generating set placed within the house. The switch of the generating set was at the on position. There was no fuel in the generator. The outbreak most likelyoccurred as a result of carbon monoxide poisoning from the fumes of a generating set used within a poorly ventilated house. There is a need for public education about proper housing ventilation, potential hazards of improperly used generating sets, and the effects of carbon monoxide.

Enquête sur une épidémie d'empoisonnement au monoxyde de carbone soupçonnée à Akure, État d'Ondo, 2014

Résumé

Le 11 juin 2014, un groupe de décès dus à une cause inconnue d'intoxication a été signalé à Oke Ogba, dans la zone du gouvernement local de sud d'Akure, dans l'État d'Ondo. Nous avons fait une enquêté pour identifier la source et proposer des recommandations. Nous avons recueilli et envoyé des échantillons de nourriture pour des tests toxicologiques afin d'identifier un agent étiologique possible. Des échantillons de sang ont également subi des tests. Entre le 11 juin et le

28 juin 2014, 8 cas (5 enfants et 3 adultes) ont été identifiés dans le ménage (taux d'attaque : 100%). Six décès ont été enregistrés (létalité : 75%). Le taux de létalité était plus élevé chez les enfants, 4 sur 5 (80%). Plus de femmes (4/6, 67%) sont mortes que les hommes. Les échantillons d'aliments n'étaient pas positifs pour les échantillons testés. Il y avait des preuves qu'un générateurélectronique avait été utilisé avant l'incident. Un parcours d'enquête a montré une maison mal ventilée avec un générateur électronique placé dans la maison. L'interrupteur était en position de marche. Il n'y avait pas de carburant dans le générateur. L'éclosion s'est probablement produite à la suite d'une intoxication au monoxyde de carbone due aux émanations de générateur utilisé dans une maison mal ventilée. Il est nécessaire d'informer le public sur la ventilation appropriée du logement, les dangers potentiels des générateurs électroniques mal utilisés et les effets du monoxyde de carbone.

Introduction

Since 1990's, many Nigerian families have lost their lives and others have been hospitalised after long exposure to fumes from electric generating sets in household settings (Chukwuma 2014 and Afolayan *et. al.* 2014). An increase in the reported deaths through generator-related accidents in Nigeria has been associated with the epileptic power supply by the Power Holding Company of Nigeria (Nnoli 2009 & Olufemi 2014). Currently, there are about 60 million generators in Nigeria at the ratio of one per household of 2.5 people (Esan 2014). Some residents put their generators inside the house while it is still switched on in order to prevent theft (Umukoro, 2013 & Gates 2015). This has led to episodes of fatal inhalation of poisonous carbon monoxide gas from generators (Afolayan *et. al*. 2014).

Carbon monoxide is an odourless, colourless gas which results from incomplete combustion of carbon-containing fuels: gasoline, wood, coal, natural gas, propane, oil and methane (Smollin & Oslon, 2010, Goldstein, 2008). Carbon monoxide poisoning is common in the United States, where it is attributed to 40,000-50,000 emergency department visits and 6,000 deaths annually. In England and Wales, an estimated 40 people (range 25-45) died from carbon monoxide poisoning between 2006 and 2011, and over 200 are admitted to hospital each year from accidental carbon monoxide poisoning; a further 4000 people present to Accident and Emergency Departments but are not admitted (McCann *et. al*., 2013). Carbon monoxide is the number one cause of poisoning in industrialized nations (Lindell & Weaver 2009, Griffin 2009). Despite the lack of accurate statistics on deaths due to carbon monoxide poisoning in Nigeria, experts suggest that it is quite high. It is expected that several cases of poisoning remain unreported, as families bury their dead without presentation at hospitals or refuse autopsies for religious, social or personal reasons (Umukoro, 2014).

When inhaled, carbon monoxide binds rapidly to haemoglobin with an affinity that is 200 times that of oxygen. The binding activity leads to the formation of carboxy-haemoglobin, the oxygen carrying capacity of the haemoglobin is reduced resulting in tissue hypoxia (Lindell & Weaver, 2009). The toxic gas becomes fatal when an individual is exposed to sustained concentrations greater than 150 parts per million (Gates 2015).The symptoms of carbon monoxide poisoning are non-specific and range in severity from mild (constitutional symptoms) to severe (coma, respiratory depression and hypotension) (Griffin 2009, Hnatov 2009). Due to its elusive symptoms, a high index of suspicion, particularly among primary care clinicians and Emergency Medicine Specialists, that carbon monoxide caused the illness is essential for making a diagnosis (Umukoro 2013, Ernest & Zibrak, 1998).

The Ondo State Disease Surveillance and Notification Officer (DSNO) notified the State

Ministry of Health of suspected food poisoning in a house in the Oke Ogba area of Akure South Local Government Area (LGA) on 11th June, 2014. A team therefore set out to investigate the suspected food poisoning with the aims of ascertaining risk factors, tracing contacts, and limiting the spread of disease. The report of the investigation is presented in this paper.

Methods

Outbreak setting

Nigeria is the most populous country in Africa, with a population estimated at 186,053,386 in July 2016 (World fact book, 2016).Ondo State is one of the 36 states in the FederalRepublic of Nigeria in the Southwestern geopolitical zone of the country. Ondo State has18 LGAs with three senatorial districts; Ondo North, Central and South and a 2015 projectedtotal population of about 4,489,756 based on the 2006 population census (NPC, 2006). The current outbreak occurred at Akure South LGA in the Central Senatorial District. Though most of the residents of Akure South LGA are elites, there are several artisans living in Akure metropolis. Some of the residents reside in houses unfit for safe habitation (Olotuah 2016)

Field work preparation

The Ondo State Epidemiologist formed a team to investigate the outbreak comprising Nigeria Field Epidemiology and Laboratory Training Program (NFELTP) residents, and the Disease Surveillance and Notification Officer. The investigation commenced on the 12th June, 2014, at the State Specialist Hospital, Akure where the household members were admitted. Despite the initial hypothesis of possible food poisoning, the investigation team assessed all possible exposures. A data collection tool was designed to obtain information retrospectively from relation/ household members of cases to identify risk factors associated with the outbreak. No data were available prior to the arrival of the team. Community members were unwilling to volunteer information, as there was a strong perception that death was due to strange breeze.

Case Identification

A field survey was conducted with the approval of relevant state and public health authorities. It involved visits to the house of the affected family and hospitals where cases were admitted. A case was defined as any resident of the affected house who died or was hospitalized on 11th June, 2014.

Descriptive Epidemiology

Line listing of the cases was done. The linelist included data on the age, sex, family relationship, clinical features, and the status (*i.e.*, alive or dead) of the case. Descriptive statistics (frequency, median and range) were calculated using Microsoft Excel.

Laboratory analysis

Blood samples were collected from the three cases that were alive at the onset of investigation to rule out infective causes. Random blood sugar measurements and other routine blood tests to monitor the cases were carried out using standardized instruments in the Laboratory of Federal Medical Centre, Owo and State Specialist Hospital, Akure. The outbreak team collected specimens of cooked soup and uncooked food items (rice, beans, palm oil and vegetable oil) and two different water samples from the house of the cases. Samples were sent to Nigeria National Agency for Food and Drug Administration and Control (NAFDAC) Laboratory for toxicological analysis. Arterial blood gases estimation could not be done either at the State Specialist Hospital Akure and the Federal Medical Centre, Owo where the patients were admitted. The family members did not give consent for autopsy to be done.

Ethical approval: Not applicable

Results

On the evening of 10th June, 2014 three family members were brought unconscious to the Accident and Emergency unit of the State

Specialist Hospital, Akure by a taxi driver. Two out of the three patients were referred to the Federal Medical Centre Owo on 11th June 2014 for further management.

Table 1: Sociodemographic Characteristics of Cases in Outbreak Investigation, Ondo State, 2014

Characteristics	Frequency	%
Sex distribution		
Male	3	37.5
Female	5	62.5
Age group in years		
<18	5	25
18 and above	3	75
Family relationship		
Father	1	12.5
Mother	1	12.5
Son	2	25
Daughter	2	25
Maternal Grand Mother	1	12.5
Maternal Nephew	1	12.5
Outcome		
Alive	2	25
Dead	6	75

A total of eight cases were included in the investigation (Table 1). The attack rate was 100%, as all residents of the household were affected. The overall case fatality rate (CFR) was 75% (6 died out of 8). The case fatality rate was higher among children (80%, 4 died out of 5). The median age of cases was 23 years (Range: 1.5-70 years).

Environmental and walk through survey

The house of the affected family was a mini bungalow with poorly ventilated rooms. Figure 1 shows the front view of the house. The kitchen was in close proximity to the sitting room and other adjoining rooms. Food samples were collected from the kitchen (Figure 2). No doors separated the rooms from each other. At the time of visit, a generating set was found inside the house, at its usual position, close to the entrance of the kitchen. The fuel tank of the generating set in the victim's house was opened. Though no fuel was in the tank, it was gathered from the neighbors that the generating set was used on the day of the incident (10th June, 2014). This raised suspicion that use of the generating set (Figure 3) could have been related to the incident.

Figure 1: Front view of the house undergoing investigation in Akure, 2014

Figure 2: Collection of food specimen at the house undergoing investigation in Akure, 2014

Figure 3: Generator with switch on and empty fuel tank at the house under investigation in Akure, 2014

Table 2. Frequency Distribution of Symptoms/Signs and Outcome of Cases of Carbon monoxide poisoning, Ondo State, Nigeria, June 2014

	Cases		
Age	30 years	32	10
Sex	Female	Male	Male
Glasgow Coma Score (GCS)	3/15	4/15	13/15
Signs/Symptoms	Drooling of Saliva	Facial Swelling	Fecal incontinence
Vital Signs	Pulse rate, respiratory rate and Blood Pressure normal	Pulse rate, respiratory rate and Blood Pressure normal	Pulse rate, respiratory rate and Blood Pressure normal
Outcome	Alive	Dead	Alive

Case 1 mouth was suctioned and was placed on oxygen while being nursed as an unconscious patient. She was discharged after spending 16 days in the hospital. Although her memory of the night of the incident was impaired, the case mentioned that the family members were in the sitting room and suddenly the breeze was making them dizzy.

Case 2 was managed in the Intensive Care Unit of Federal Medical Centre, Owo. His laboratory results revealed a Potassium level of 5.8 mmol/l (reference 3-5 mmol/l), Bicarbonate level of 20mmol/l (reference 20-30 mmol/l), Chloride of 89mmol/l (reference 95-110), Creatinine of 117µmol/l (reference 50-132µmol/l), and Urea of 5.6mmol/l (reference 2.5-5.8 mmol/l).His park cell volume was 41% while ECG showed sinus rhythm. Case management involved administration of antibiotics and oxygen. He died on Saturday 28th June 2014 at the Intensive care unit of the Federal Medical Centre, Owo.

The electrolyte urea and creatinine test for Case 3 revealed a Potassium level of 5.8 mmol/l, Bicarbonate level of 20mmol/l, Chloride of 89mmol/l, Creatinine of 107µmol/l, and Urea of 6.1 mmol/l. His management included the use of antibiotics and oxygen administration. He was nursed as an unconscious patient. He was discharged to continue physiotherapy due to weakness of both lower limbs on the 29th June, 2014.

Food samples sent to NAFDAC did not test positive for pesticides residue and pathogens.

Discussion

The investigating team set out to investigate the case of a suspected food poisoning in Akure, Ondo State Nigeria. Given the lack of pathogens detected in food specimens and the observations of a generating set inside the poorly ventilated house, it was plausible to conclude that the outbreak occurred as a result of carbon monoxide poisoning. This led to the death of 6 out of 8 family members. Carbon monoxide poisoning is considered to be one of the leading causes of death and injury due to poisoning. Illness due to inhalation of carbon monoxide is challenging to differentiate and diagnose. Deaths from carbon monoxide poisoning remain a regular occurrence in Nigeria.

A study carried out by Afolayan *et al* in 2014 among personnel working at Federal Medical Center, Owo to evaluate awareness of and attitude of the personnel towards the dangers of carbon monoxide poisoning revealed that the health-related dangers of the poisonous gas as a result of operating electrical generators indoors were poorly appreciated, even by health workers (Afolayan *et. al,* 2014). Akinyemi and colleagues investigated the carbon monoxide concentration from anthropogenic sources in 8 Local Council Development Authorities in Lagos state. It was revealed that the equipment operated on diesel has highest concentration of carbon monoxide than those operated on petrol (Akinyemi *et. al.,* 2013). A case study carried out by McCann et al quantified population exposure to the gas in an inner city setting as well as promoted realistic interventions to reduce potential exposure (McCann*et al.,* 2013) Intervention was delayed in the case presented here due to unavailability of a confirmatory test for carbon monoxide poisoning. A systematic review carried out by Smolin and Oslon in 2010 sought to provide information on the effects of oxygen treatments for acute carbon monoxide poisoning. They presented information on the effectiveness and safety of the following interventions: 100% hyperbaric oxygen, oxygen 28% and oxygen 100% by non- breather mask (Smollin & Oslon, 2010). Also in 2013, Kayode *et al* carried out a study in Lagos to determine the level of human exposure to the gas using a carbon monoxide detector. It was found out that the level of carbon monoxide emission from commercial areas, residential areas, household kitchen, and eateries is tolerable by the human system and considerably less threatening. However, the emission of the gas from petrol and diesel generators, cars, motorcycles and trucks depict a level of carbon monoxide that is highly toxic to the human body (Kayode & Kamson, 2013).

There is a need for public enlightenment about carbon monoxide poisoning in order to reduce the numbers of associated death. Recommendations on how clinicians can effectively detect and treat

patients with carbon monoxide poisoning in resource-limited settings will be critical.

Conclusion

Signs and symptoms, observations, and anecdotal evidence from neighbors supported carbon monoxide poisoning from generating set exhaust as the source of the deaths. There is the need to educate the masses continuously about the effect of carbon mono-oxide poisoning, particularly due to misuses of generating set. The State Epidemiologist promised to inform the state ministry of health to sponsor a jingle on the radio to sensitize the masses on the harmful effect of carbon monoxide poisoning.

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Conflict of interest

Authors have declared that no competing interests exist.

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