Gazette of Medicine
A Peer-reviewed Medical Journal of the Association of Resident Doctors
University of Port Harcourt
Teaching Hospital,Port Harcourt,
Rivers State, Nigeria
Volume 11 No 1, Jun. 2023 - Nov, 2023

PATHOLOGY OF DEATHS FROM SEVERE FIRE BURNS AMONG CHILDREN AND ADOLESCENTS IN THE NIGER DELTA REGION OF NIGERIA- AN AUTOPSY STUDY OF 183 CASES

Seleye-Fubara Daye[1], Ugwa Okezie Chinedu[1], Musa Itopa Stephen[1]

1 Department of Anatomical Pathology University of Port Harcourt Teaching Hospital

Correspondence: okezie.ugwa@npmcn.edu.ng

ABSTRACT

Background: *Death from severe fire burn is a common environmental, domestic and industrial problem requiring a thorough research into the cause, course (circumstances), and pattern of death.*

Methodology: *Coroner's autopsies performed by the authors in different parts of the Niger Delta region of Nigeria, where the circumstances of death and autopsy findings fit into severe fire burns and/or its complications were studied over eight years (1st January 2005- 31st December 2020. At the end of the autopsies, reports were given to the Coroner through the Police.*

Results: *A total of 1265 medico legal autopsies were performed by the authors during the period under review. Out of these, 183 (10.5%) were due to fire burns. Of the 183 fire deaths, 95 (71.4%) involved children and adolescents aged 23 years and below. Sixty three (66.3%) were males while 32 (33.7%) were females, giving a ratio of 2:1. The youngest was a 4 years male while the oldest was 23 years old. The highest frequency occurs at the age group 20 to less*

than 25 years 30 (31.6%) cases. Deaths from kerosene, cooking gas, and other household fire were commoner in females, whereas fire from crude oil pipeline explosion was commoner in the adolescent males. The pipe line explosion constituted the most common cause of fire 31 (32.6%). Fumes (carbon monoxide poising) were the commonest cause of death 75 (78.9%) and all our cases occurred either in accidental or homicidal circumstances.

Conclusion: *Death from severe fire burns is a common but preventable environmental problem. There is need for public enlightenment about the dangers associated with tampering with crude oil pipelines and keeping petroleum products carelessly in and around homes where naked flames are frequently used.*

Keywords*: Death, fire burns, causes, Niger Delta region, Nigeria.*

INTRODUCTION

The Niger Delta region of Nigeria is made up of Rivers, Delta, Edo, Bayelsa, Cross River, Abia and Akwa Ibom States, which bear the bulk of the nation's oil and gas reserves. It thus attracts oil and natural gas industries and all manner of people seeking for employment including criminals. There are numerous high pressure pipelines transporting the crude oil from the well to the industries where they are refined to various petroleum products and gas or exported overseas. These pipelines sometimes explode on their own or are vandalized by criminals and their content ignited accidentally causing raging inferno and death.

A burn is a local tissue destruction involving the skin with or without the involvement of the underlying structures by dry heat, moist heat (scald), corrosive chemicals and electric spark discharge[1]. The morphological patterns of the above situations are alike. Fire burns are common domestic and industrial accidents worldwide. They vary from minor insignificant accidents to the most severe injuries experienced by man[2].

Domestic fire remains a significant source of paediatric morbidity and mortality. Children of less than 5 years of age and the elderly are known to be in the highly vulnerable age group. Others are those with physical or cognitive disability or persons under the influence of alcohol or other drugs, defective electrical wiring and kerosene stove explosion, petroleum product ignition and domestic fire outbreaks[3].

Death from fire may be accidental, homicidal or suicidal depending on the circumstances and autopsy findings. The diagnosis of fire death can be correctly made when appropriate history and circumstantial evidence are considered. However, suicidal fire death is uncommon worldwide due to agonising pains associated with naked flame[4], but it is found to be more common in Egypt and Asia[1].

Studies have shown that, not all the bodies recovered after the fire must have died from the effect of the fire although, there may be features indicative of burns[5]. The severity and prognosis of burns is related to the body surface, depth of the burnt area and the age of the victim[2,5]. Fire deaths may occur before, during and after the fire[5]. It is also difficult to differentiate ante mortem from post mortem burns[1,4,5]. This study is aimed at elucidating the characteristics of death from severe fire burns in the Niger Delta region of Nigeria.

MATERIALS AND METHOD

An autopsy study was carried out by the authors on bodies in which the circumstances of death and autopsy findings fitted into the fire related deaths in different parts of the Niger Delta region of Nigeria after being served with the coroner's inquest forms by Police from 1st January 2005 to 31st December 2020.

The bio-data and other variables analyzed for the study were extracted from the coroner's inquest form, autopsy findings, eyewitnesses and relations. They include the age, sex, cause of the fire, and the cause of death at autopsy. In each of the cases, a thorough autopsy following standard method was adopted. These data were collated, analysed and tabulated to determine the frequency of these fatalities.

RESULTS

A total of 1265 medico legal autopsies were performed by the authors during the period under review. Out of this number, 183 were fire related cases of which 95, constituting 7.5% of the total autopsies and of all fire related deaths, occurred in victims aged 0-23 years, which were used for the study and all had adequate records.

Table I shows the analysis of circumstances of death by fire: accidental fire death 68 (71.6%), homicidal fire death 27 (28.4%) and no suicidal fire death.

Table II shows age and sex distribution of severe fire death. The youngest was a 4 year old male while the oldest was a 23 year old male. Males were more involved 63 (66.3%),

while females were 32 (33.7%), giving a ratio of 2:1 male dominance. The highest frequency of death occurred in the age 16-23 years 61 (59.0%) with a peak at the age group 20 to less than 25 years 30 (31.6%). In all ages, males were predominating except the age group 16-20 years where more females were involved.

Table III shows the frequency distribution of cause of fire. The highest frequency was due to crude oil pipeline explosion 31 (32.6%). The least 1 (1.1%) was from electrical spark. These two extremes are punctuated by petrol 23 (24.2%), house hold firewood 16 (16.8%), kerosene 13 (13.7%), candles 9 (9.5%) and cooking gas explosion 2 (2.1%). Deaths related to cooking gas explosion, kerosene and house hold fire wood were commoner in females while those due to petrol and crude oil pipeline explosion were commoner in males. Fig. 1 are multiple victims of petrol pipeline explosion burns while fig. 2 is a victim of kerosene stove explosion burns.

Table IV shows the Lund-Browder Chart for estimating the extent and percentage of burns relative to body surface area in children[8].

Table V shows the distribution of cause of death at autopsy. Fumes (carbon monoxide poisoning) 75 (78.9%), septic shock 17 (17.9%), dehydration/hypovolaemic shock 2 (2.1%) and direct heat from fire 1 (1.1%).

Table 1: Circumstance of death from fire burns.

Circumstances of death	Total	(%)
Accident	68	(71.6)
Homicide	27	(28.4)
Suicide	-	-
Total	95	**(100.0)**

Table II: Age and sex distribution of victims of fire burns.

Ages in years	Sex			
	Male	**Female**	**Total**	**(%)**
0-4	5	3	8	(8.4)
5-10	9	5	14	(14.7)
11-15	12	5	17	(17.9)
16-20	12	14	26	(27.4)
21 < 25	25	5	30	(31.9)
Total	**63 (66.3%)**	**32 (33.7%)**	**95**	**(100.0)**

Table III: Frequency distribution of cause of fire

Cause of fire	Male	Female	Total	(%)
• **Crude oil pipeline explosion**	26	5	31	(31.6s)
• **Petrol**	20	3	23	(23.2)
• **House hold fire wood**	7	9	16	(16.8)
• **Kerosene stove explosion**	5	8	13	(13.7)
• **Candle**	4	5	9	(9.5)
• **Cooking gas explosion**	-	2	2	(2.1)
• **Electrical spark**	1	-	1	(1.1)
Total	**63**	**32**	**95**	**(100.0)**

Sex

Table IV: Lund-Browder Chart (for children) for estimating extent of burns (relative % of body surface area)

Body parts	Age in years					
	<1 yrs	**1 yrs**	**5 yrs**	**10yrs**	**15 yrs**	**Adult**
a. Half of the head	$9^1/_2$	$8^1/_2$	$6^1/_2$	$5^1/_2$	$4^1/_2$	$3^1/_2$
b. Half of the thing	$2^3/_4$	$3^1/_4$	4	$4^1/_4$	$4^1/_2$	4
c. Half of one lower leg	$2^1/_2$	$2^1/4$	$2^3/_4$	3	$3^1/_4$	$3^1/_2$

Table V: Frequency distribution of cause of death

Cause of death	Total	%
• **Fumes from fire (carbon monoxide poising)**	75	(78.9)
• **Septic shock**	17	(17.9)
• **Dehydration / hypovolemic shock**	2	(2.1)
• **Direct heat of fire**	1	(1.1)
Total	**95**	**(100.0)**

Table VI : Wallace's Rule of Nine (For Adults) for the Estimation of Body Surface Area Involved in Burns

Anatomic areas	% of body surface
• **Head and neck**	**9**
• **Right upper limb**	9
• **Left upper limb**	9
• **Right lower limb**	18
• **Left lower limb**	18
• **Anterior trunk (thorax and abdomen)**	18
• **Posterior trunk (thorax and abdomen)**	18
• **External genitalia and perinieum**	1

Figure 1: Multiple victims of burns

Figure 2 A 16year old victim of kerosene stove burns

DISCUSSION

Fire burns occur when a dry heat is applied to the skin directly. The extent and severity of the burn depends on the temperature of the heat, the ability of the body to conduct away the excess heat and the duration of application of the heat[1]. The extent of injury varies from mere reddening to total cremation of the body. Studies have shown that, it takes about five hours for a 44°C heat to cause harm whereas three to five seconds is enough to cause the same harm when the temperature is at 60°C [5]. Similar to the burnt area in adults which is clinically

estimated by the 'rule of nine' that takes into cognizance the depth of the burnt skin[6,7] which is of prognostic value, the Lund-Browder chart was used to estimate the extent of burns in children up to 15 years[8].

Burns can be classified into partial thickness (superficial or first degree) burns when it is limited to the epidermis and heals without scaring. This type often blisters and the adjacent skin becomes hyperaemic which is otherwise known as 'vital reaction'. It is second degree burn or full thickness burn when it extends to the dermis causing epidermal coagulation, tissue necrosis and heals with scar formation. It is third degree when there is destruction of the deeper layer of the skin. Second and third degree burns heal slowly and they are usually complicated by infection[6,8].

Death from fire is a common domestic and industrial accident in this environment. It can be accidental, homicidal or suicidal, but suicidal fire death is rare worldwide[1,9,10]. This is corroborated by our study that recorded no suicidal fire death. The reason may be attributed to the agonizing pains associated with fire burn, Majority, (71.6%) of our case were accidental which may be attributed to the fact that, criminals and illegal crude oil bunkers usually vandalize high pressure oil pipelines to procure the product, which in most cases burst into flames and kill the victims. Highly inflammable substances like petrol, kerosene and cooking gases are frequently stored at home in anticipation of scarcity which accidentally burst into flame and cause death in many instances. The accidental fire death is further aggravated by the frequent instability of electricity supply, causing increased use of naked flames such as candles and kerosene lamps, which are recipes for fire accidents at homes and deaths[11]. Homicidal fire death is generally rare but seen frequently in this environment. It involved 28.4% of cases in this study. In 15.8% of cases the bodies were burnt by militants and other assailants. It may be possible that bodies were killed before being burnt to conceal homicide so as to escape arrest by law enforcement agents[12]. Twelve

victims (12.6%) were burnt deliberately in different episodes of arson by militants and gangs during their clash. There is no difference in the findings at autopsy between victims of the two circumstances of homicidal fire death.

Males were more involved (66.3%), reason being that they are more aggressive, ambitious and therefore the likelihood of getting killed in aggressive circumstances when compared to females corroborating male dominance recorded in other studies[13-17]. The bulk of fire death (59.0%) occurred within the ages of 16-23 years with a peak (31.6%) at the age group 20 to 23 years. This age group is usually engaged in oil and gas pipeline vandalisation and perpetrators of gang violence[11]. Children who are always exploring their environment continually fall into fire and get burnt. Epileptics and other infirm patients are particularly at risk of fire accident and subsequent death since they cannot escape from the fire at the time of the attack. Females of ages 16-20 were more involved in fire death than males of the same age group in this study, similar to a report in this centre, though the study also included adults[11]. This is because females of this age group are more involved in domestic duties with fire than males in this environment. This study also recorded a severely burnt 22 year pregnant woman who died of septic shock after aborting a 28 week old foetus. This is in similarity with a report in Northern Nigeria where most of the severely burnt pregnant women aborted their foetuses before dying of septic shock[18].

Fire burns are generally caused by petroleum and gas products which involved 72.6% of our victims. Vandalisation of crude oil pipelines is regularly practiced in this setting during illegal crude oil bunkering as reported in a previous study[18]. In several occasions, the contents of these pipelines were accidentally ignited causing a lot of deaths (**fig. 1**). On two occasions in this environment, the fire outbreak caused disasters (death of twelve people or more in a single episode[21]). The practice of storing petroleum products like kerosene at home

have killed many people at different times, as these products were accidentally ignited especially at night when there is no electricity. These accidents would have been prevented if there was electricity (**fig. 2**). Power failure and epileptic electricity supply is endemic in this environment as at the time of this communication.

The cause of death in most victims of fire was from inhalation of carbon monoxide gas, leading to cerebral anoxia. The inhaled soot particles were mixed with the mucus of the respiratory tract. This pattern of death is similar to an earlier reported cases elsewhere[21-23], Death after the fire was responsible for 21.1% of our cases of which septic shock from bacterial infection was foremost, mirroring the pattern in another study in which death usually occurs few days after the conflagration[24,25]. Other causes of death include: dehydration/hypovolumic shock with subsequent electrolyte imbalance, as the case elsewhere[8]. In children, pulmonary oedema and pulmonary insufficiency may also cause death after the fire as reported elsewhere[24], but this was not recorded by our study. In other instances, death from direct effect of heat may occur without obvious burns to the skin[21]. This pattern was noticed only in one case of our study.

At autopsy, the findings in both accidental and homicidal fire deaths were similar. The little variations depend on the degree of bums and the age of the victim because, age reflects general body health and overall resistance to traumas[5,8], Most of the findings were external, but fire burn can have a dramatic effect on both soft and hard tissues of the body, superficial and visceral structures[25]. There were skin blisters with erythematous edges (vital reaction) signifying life before the fire. Some of these blisters occasionally collapsed at the time of autopsy. In fair-skinned victims, there were skin discoloration due to smoke generated by the fire. Muscle contraction is a common post-mortem event. The flexor muscles of the forearm were bulkier than the extensors; forcing the limbs into a flexion otherwise

known as 'boxer's or pugilistic postures[6]. In severely burnt victims, there is marked skin contraction splitting the skin which is similar to ante mortem wound[6]. The skeleton does not burn in a uniform way. Some bones will burn at a higher intensity than others due to factors such as body fat distribution, proximity to the heat source. These changes ranges from discolouration, increased fracturing, fragmentation and breakage[25]. These findings may pose a lot of diagnostic problem to the inexperienced pathologist. The false spilt of the skin usually shows no vital reaction signifying post-mortem event. Pink stained froth may be seen at the mouth and the nostril as a result of heat related pulmonary oedema and injuries caused by carbon monoxide poisoning [25],

Finally, a very important proof of all fire related death is the presence of carbon monoxide in the blood of the victims, which at the time of writing could not be estimated in this setting. The presence of carbon particles in the air passage and the lungs are also very important autopsy findings to show carbon monoxide poisoning.

CONCLUSION

It is quite obvious that, death from severe fire burn is a common but preventable public health problem that needs public enlightenment about the dangers associated with tampering with high pressure crude oil pipe lines and keeping highly inflammable petroleum product carelessly in and around homes.

REFERENCES

1. Simpson, K. In Simpson K ed. Taylor's Principles and Practice of Medical Jurisprudence 12th ed *London Churchill Living Stone* 1965: pp.329-339.
2. Brown RF. Injury by Burning. In Manson's Pathology of Trauma. 2% Ed, *Edward Amold London* 1993: pp.178-191.
3. Corey TS, Collins KA. Paediatric Forensic Pathology. In Stocker and Dehner (ed.) *Paediatric Pathology,* Vol.

1, 2 ed. Lippincott and Williams & Wilkins Coy, 2002; pp.248-285.

4. Vij K. Thermal Deaths. In Textbook of Forensic Medicine and Toxicology. Principles and Practice 4th ed *Elsevier India* 2009: pp.209-228.

5. Lawler W. Bodies Associated with Fires. *J Clin Pathol* 1993; 46: 886-889.

6. Knight B. Forensic Pathology. London: *Edward Arnold* 1991: pp.281-293.

7. Tedeschi CG In. Tedeschi CG, Eckert WG, Tedeschi LG eds. Forensic Medicine. Philadelphia: WB Sounders, 1977: pp.715-729.

8. Rao NG. Death due to fire. In Rao (ed.) Textbook of Forensic Medicine and Toxicology. 2nd ed. *Jaypee, New Delhi,* 2010, pp.313-319.

9. Aydogdu HI, Ketenci HC, Askay M, Boz H, Kirci GS, Ozer E. Evaluation of the fire-related deaths: Autopsy study. *Ulus Travma Acil Cerrahi Derg* 2021;27:539-546.

10. Rutty GN. Fire Deaths. In Payen-James (ed.) Forensic Medicine, Clinical and Pathological Aspect. *Greenwich Medical Media (GMM) Ltd, London*, 2003; pp.349-373.

11. Seleye Fubara D, Ekere AU. Domestic Accidental Deaths in the Niger Delta Region, Nigeria. *East Afr Med J* 2003; 80: 622-626.

12. Seleye Fubara D, Bob-Yellowe. Traumatic Deaths from Rival Gang Violence in Rivers State, *Nigeria Med Sci Law* 2005; 45; 340-344.

13. Amakiri CNT, Akang EEU, Aghadiuno PU, Odesanmi WO. A Prospective Study of Coroner's Autopsy in UCH Ibadan *Med Sci Law* 1997; 37: 69-75.

14. Sully, C.J., Walker, G.S. & Langlois, N.E.I. Review of autopsy reports of deaths relating to fire in South Australia 2000–2015. *Forensic Sci Med Pathol* **14**, 180–187 (2018). https://doi.org/10.1007/s12024-018-9981-y

15. Elmes BGT. Forensic Medicine in Uganda (A Five Year Survey) *East Afr Med J*. 1957; 34: 41-45.

16. Chao TC. Homicide and Suspected Homicide in Singapore. *Med Sci Law* 1973; April: 98-102.

17. Holinger PC. Violent death as a leading cause of mortality: An Epidemiologic Study of Suicide, Homicide and Accidents. *Am J Psych* 1980; 137: 472-476.

18. Chama CM, Na'Aya HU. Severe Burn Injury in Pregnancy in Northern Nigeria. ***J Obstet Gynaecol*** 2002; 22: 20-22.

19. Seleye Fubara D, Bob-Yellowe E. Industrial Accidental Deaths in the Niger Delta Region of Nigeria: A Study of 32 Autopsies in Port Harcourt *Med Sci Law* 2006; 46: 342-348.

20. Rutherford W. DeBoer J. The Definition and Classification of Disaster. *Injury,* 1983; 15: 10-12.

21. Hill IR. Immediate Cause of Death in Fires. *Med Sci Law* 1989; 29: 287-292.

22. Noguchi TT, Eng JJ, Klatt EC. Significance of Cyanide in Medico Legal Investigation Involving Fires. *Am J Forensic Med Pathol* 1988; 9: 304-309.

23. Gormsen H. Jappesen N, Lund A. The Causes of Death in Fire Victims. *Forensic Sci Int* 1984; 24: 107-111.

24. Demling RH. Burns. *N Engl J Med* 1985; 313: 1389-98.

25. Durham University, Forensic archaeology and anthropology. What happens to human bodies when they are burned? (Internet). Cited 2023Nov. 10.
Available from: https:/www.futurelearn.com>steps.

25. Lopez ON, Cambiaso-Daniel J, Branski LK, Norbury WB, Herndon DN. Predicting and managing sepsis in burn patients: Current

perspectives. *Ther Clin Risk Manage* 2017;13:1107–17

26. Reynolds EM, Ryan DP, Doody DP. Mortality and Respiratory Failure in a Paediatric Bums Population. *J Paedi Surg* 1993; 28: 1326-133.