CONTAMINATED KEROSENE BURNS DISASTERS IN LAGOS, NIGERIA

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SUMMARY. A longitudinal study was conducted of patients who sustained thermal burns resulting from the use of contaminated kerosene and were seen at an emergency medical centre in Nigeria over a seven-week period between October and November 2001. Burns of at least 10% in children and 15% or more of the body surface area in adults were classified as major. Most patients were managed with open dressings, systemic antibiotics, intravenous fluids, or oral fluids depending on the severity of the burns. One hundred and thirty-nine patients were seen; 83 (59.7%) were females and 56 (40.3%) were males. Ninety-three (67.6%) were older than 15 years of age and 46 (33.0%) were children. The mean age was 23.4 ± 14.1 yr. Most of the burns (96.4%) resulted from the use of hurricane lamps. The mean burn surface was 24.1 ± 21.3%. The upper limb was the most frequently affected region of the body. Eighty-six (61.9%) of the patients had major burns, of whom 18 died, giving a case fatality rate of 12.9%. All the dead patients had major burns (p = 0.0009) and burned body surface area greater than 15% (p = 0.00001). Contaminated kerosene is associated with high mortality, and more care is needed in its storage, distribution, and use.

Introduction

Burns place a major burden on societies.[1] They have a variety of causes: chemical,[2,3] electrical, industrial, and thermal.[4] In Nigeria, burns have been reported to occur from the use of sitz baths[5] and kerosene lanterns.[6] Although burns frequently occur in the home,[1] thermal burns are more common in the work place.[4] However, burn cases tend to occur sporadically, except when there are disasters due to arson, bush fires, volcanic eruptions, and contamination by petroleum products such as kerosene.

Kerosene is one of the products obtained when crude oil is refined. Although Nigeria is the sixth largest producer of crude oil amongst members of the Organization of Oil Producing Exporting Countries (OPEC), petroleum products, especially kerosene, are not always available. Kerosene is more readily available through subdealers and retailers than at licensed pump stations. The poorer segments of Nigerian society use kerosene for cooking and lighting hurricane lamps when electric power outage (which is common) occurs. When kerosene is contaminated with premium motor spirit (PMS), the "flash point" (45 °C) is lowered and approaches that of PMS itself (usually between 25-30 °C), making the product more flammable.[7] Such contaminated kerosene explodes into balls of fire on contact with a lighted matchstick, harming the user in the process.

This paper reports on a burns disaster that occurred in Lagos, Nigeria, in the last quarter of 2001 owing to contaminated kerosene. A similar large-scale burns disaster had already occurred in Edo State[7] some 18 months before the disaster in Lagos, but we are unaware of its being reported in the medical literature.

Methods

Patients

The study population consisted of all patients sustaining burns injury between October and November 2001 who reported at the Lagos State Accident and Emergency Centre, Ikeja, Lagos. This centre was established in 1998 primarily to manage road traffic accidents and other emergencies. Because of the large number of burns patients seen during the period, a burns unit was established within the facility to manage the patients. The large number was also due to mass media announcements made by the government regarding the availability of free treatment for burns patients.

Lagos State is the commercial capital of Nigeria and is politically divided into 20 local government areas. All patients were assessed on arrival and appropriate management was instituted. The information obtained from patients included age, sex, and

cause of burns while burned body surface area (BSA) was estimated using Wallace's rule of nine.[8]

Surgical management

All patients were assessed on arrival at the centre and those without major burns (< 10% in children and < 15% in adults) were managed as outpatients. Silver sulphadiazine was applied to burned surfaces, while the patients received analgesics and haematinics along with an ampicillin/cloxacillin combination and metronidazole. The antibiotics were prescribed for prophylaxis. All these patients were invited to return to the burns clinic after one week. Patients with major burns were hospitalized. A strict fluid input and output chart was initiated. The patients were rehydrated with crystalloid fluids at a rate corresponding to the percentage BSA multiplied by body weight (kg) multiplied by 2%. The first half of the fluid replacement was given in the first 8 h and the balance over the successive 16 h. Patients also received ciprofloxacin and metronidazole, while open dressing with silver sulphadiazine was performed, this being changed to honey after the third day of admission in most patients. All patients received tetanus toxoid.

Data analysis

Information obtained from patients was entered into a computer and analysed using Epiinfo v 6.04c

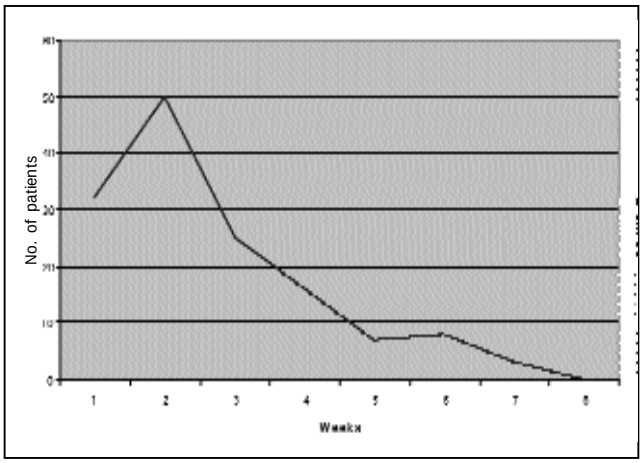

Fig. 1 - Epidemic curve of contaminated kerosene burns.

software. Frequency distribution of variables was determined, and a statistical significance between variables was sought for. The level of significance was set at $p < 0.05$.

Results

One hundred and thirty-nine patients were seen over a seven-week period. The peak period of admission was in week 2, which was also the median period of presentation (*Fig. 1*). By the second week, 77 of the patients (55%) had been seen; this rose to 76% by the third week and declined thereafter, save for a small increase observed during the sixth week. Patients were seen from 14 (70%) out of the 20 local government areas in the state, with 70 (50%) residing in areas that share borders with the Ikeja local government area, where the facility is located.

Table I - Age and gender distribution of patients

Variable	Number of patients	Percentage
Age (yr)		
< 5	10	7.2
5-9	11	7.9
10-14	24	17.3
15-19	18	12.9
20-24	15	10.8
25-29	19	13.7
30-34	12	8.6
35-39	13	9.4
40-44	4	2.9
45-49	7	5.0
50-54	1	0.7
55-59	2	1.4
> 60	3	2.2
	139	100
Sex		
Female	83	59.7
Male	56	40.3
	139	100

The mean age of the patients was 23.4 ± 14.1 yr, with a male:female ratio of 2:3 and an age range of 1-73 yr. Children under 15 yr (n = 46) constituted 33% of the population, while adults (n = 93) accounted for 67%. However, there were more male children (27/46 = 59%) than females, unlike the adult population, where females amounted to 69%

Table II - Percentage burned body surface area (BSA)

Percentage burned BSA	Number of patients	Percentage
< 5	23	16.6
5-9	17	12.2
10-14	15	10.8
15-19	17	12.2
20-24	9	6.5
25-29	10	7.2
30-34	9	6.5
35-39	6	4.3
40-44	12	8.6
45-49	6	4.3
50-54	5	3.6
> 55	10	7.2
	139	100

(p = 0.003). The mean age of the female patients (24.5 ± 12.3 yr) was similar to that of the males (21.7 ± 16.4 yr (p = 0.25) (*Table I*).

Sixty-five patients (46.8%) were students, 58 (41.7%) were artisans, e.g. tailors and fashion designers, 7 (5.0%) were housewives, 5 (3.6%) were junior government workers, and 4 (2.9%) were senior government workers. Sixty-three (45.3%) were married. Seventeen patients (12.3%) had other family members involved in the disaster, with up to three or four family members in some cases - 39 individuals with intra-familiar involvement were thus identified.

Table III - Distribution of body parts burned

Body part	Number of patients	Percentage
Head and neck	55	19.0
Upper limb	82	28.4
Lower limb	67	23.2
Trunk	46	15.9
Abdomen and perineum	32	11.1
Whole body	7	2.4
	289	100

The immediate vehicle of the explosion was a hurricane lamp in 134 cases (96.4%), while in 5 patients (3.6%) it was a cooking stove. Eighty-four patients (60.4%) presented at our centre on the day they suffered their burns, while 28 were seen within 24 h of the incident. Thus 112 (81%) of the patients came to the facility within 24 h of sustaining their burns injury. The mean duration of the intervening time between the injury and presentation was 0.9 ± 0.1 h (SEM). The percentage of burned BSA is presented in *Table II*. The mean BSA was 24.1 ± 21.3% with a range of 2 to 99%. Eighty-six patients (61.9%) had major burns, occurring in 66.3% (55/83) of female patients and in 55.4% (31/56) of male patients (p = 0.26). Fifty-six adults (60.2%) and 30/46 children (65.2%) had major burns (p = 0.7). The mean BSA amongst males (20.3 ± 20.1%) and females (26.6 ± 21.9%) was comparable (p = 0.09). The mean BSA amongst adults (25.3 ± 22.0%) and children (21.6 ± 19.8%) was also similar (p = 0.33).

Table IV - Determinants of mortality

Variable	Number of dead	Percentage	p
Age (yr)			
< 15	13/93	14.0	
> 15	5/46	10.9	0.81
Sex			
Female	15/83	22.1	
Male	3/56	5.4	0.053
BSA category			
Minor	0/53	0.0	
Major	18/86	20.9	0.0009

Table III presents data regarding the regions of the body involved, the upper limb being the most affected. Eighteen patients died, giving a case fatality rate of 12.9%. The mean BSA was significantly higher in patients who died (57.2 ± 25.8%) than in those who survived (19.2 ± 15.5%) (p = 0.0000). Burned BSA was the only significant predictor of fatality as all deaths occurred in patients with major burns, i.e. 18 out of 86 or 20.9% (p = 0.0009) and in both adults and children with burns greater than 15% (p = 0.00001). Eleven per cent of paediatric patients and 14% of adult patients died (*Table IV*).

The lowest BSA associated with mortality was 18%, while above 80% BSA there were no survivors. Only three out of the 18 deaths (16.7%) - two chil-

dren and one adult - occurred in patients with BSA < 40%, while the rest of the patients who died had 40% or more BSA. The number of days between the burns injury and presentation to hospital did not have a significant association with death (p = 0.96).

Discussion

The burns disaster presented in this study was statewide, with patients coming from at least 70% of the local government areas of the state. Although about half the patients came from areas close to our facility, we do not know the outcome of those who lived farther away and were unable to reach the centre or were taken to other facilities.

The social class distribution of the patients, as judged by their occupation, is in keeping with the use of kerosene largely by the poorer segment of the Nigerian populace. The intra-familiar involvement may also be a reflection of low socio-economic status, particularly of substandard housing and of efforts by other family members to save one another. The large number of children found in the study is probably related to the use of kerosene for lighting purposes that are routinely left to children. Furthermore, we observed that many of the children were preparing for the external General Certificate Examinations and needed an alternative source of power because of the erratic electricity supply.

The distribution curve resembles that of a propagated epidemic, although the source of contamination was traceable to a storage depot of one of the major petroleum marketing companies in Lagos. The kerosene was supplied through a distribution line used for petrol without adequate precautions to completely "wash off" the petrol. The propagated nature of the disaster was due to the fact that the product was supplied to different parts of Lagos at different times and that many of the subdistributors moved from one part of the metropolis to another in search of the product.

We also observed that 80% of the patients reported within the first day of the injury, probably because of the intense publicity given to the disaster in the mass media.

We found that the upper limb was the most frequently burned part of the body, followed by the lower limb and the face, a finding that is consistent with reports from other studies.[2,9] The involvement of the upper limb may be due to the fact that patients held the hurricane lamps up while lighting them rather than placing them on a flat surface.

The proportion of our patients who had major burns (62%) was similar to the 70% reported from Ilesha, Nigeria.[10] The mean BSA obtained amongst these patients was lower than the 46% due to kerosene reported in one study.[11] The case fatality rate of 12.9% in this study lies in between the rates of 8%[10,12] and 17%[11] reported from Nigeria but is similar to the 16% reported from Iran.[13]

As was to be expected, the extent of burns was a significant predictor of mortality. The extent of burns of patients who died is similar to that reported in the literature.[13] Though there were more burns amongst females, probably because of domestic duties such as cooking, this finding failed to reach statistical significance. We did not find any other significant predictor of death. The management of our patients, especially that with open dressings and the use of honey, is in conformity with treatment used by other workers,[10] while antibiotics were used for prophylaxis, in order to prevent wound infection, especially in view of limited funds and facilities available for microbial culture and susceptibility.

Conclusions

In conclusion, between October and November 2001, one in eight patients in this study population died. These deaths were avoidable and have left the affected families with financial and other losses. We recommend that continuous surveillance be exercised over the distribution of kerosene. There is a need for a rapid response emergency infrastructure that would have helped to contain the epidemic within one or two weeks. This could become feasible with the establishment of a disaster management team and a well-conducted exchange of the product in order to withdraw all contaminated products from circulation and thus prevent further harm to the populace. There is the need for the government to make the electricity supply more regular.

RESUME. Les Auteurs ont effectué une étude des patients atteints de brûlures thermiques causées par l'emploi de kérosène contaminé et traités dans un centre de soins médicaux d'urgence en Nigeria pendant la période de sept semaines entre octobre et novembre 2001. Les brûlures qui touchaient au moins 10% de la surface corporelle dans les enfants et 15% ou de plus dans les adultes ont été classifiées comme des brûlures majeures. La plupart des patients ont été traités moyennant les pansements ouverts, les antibiotiques systémiques, les liquides intraveineux ou les liquides oraux selon la sévérité des brûlures. Cent trente neuf patients ont été traités; 83 (59,7%) étaient du sexe féminin et 56 (40,3%) masculin. Quatre-vingt-treize (67,6%) avaient plus de 15 ans, et 46 (33,0%) étaient en âge pédiatrique. L'âge moyen était 23,4 ± 14,1 ans. La plupart des brûlures (96,4%) ont été provoquées par l'emploi des lampes-tempête. La surface moyenne brûlée était 24,1 ± 21,3%. Le membre supérieur était la région corporelle atteinte le plus fréquemment. Quatre-vingt-six (61,9%) patients présentaient des brûlures graves, dont 18 sont morts, ce qui correspond à un taux de mortalité de 12,9%. Tous les patients décédés avaient des brûlures graves (p = 0.0009) et une surface corporelle brûlée supérieure à 15% (p = 0.00001). Le kérosène contaminé s'associe à un taux élevé de mortalité et il faut exercer une attention majeure pour ce qui concerne son emmagasinage, sa distribution et son emploi.

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