



Factors Influencing Mortality and Outcome of Burns from a Trauma Registry in Nigeria: A Retrospective Study

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Authors' contributions

This work was carried out in collaboration between both authors. Both the authors made substantial contributions in the study design, implementation and write up. Both authors read and approved the final manuscript.

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ABSTRACT

Background: Burns injury has a global distribution and contributes to trauma mortality and morbidity. Whereas mortality from burns is reducing in most developed countries, the picture in developing countries such as Nigeria still remains gloomy. Better understandings of the pathophysiology of burns and improvement in burns care are reasons for the improved outcome of burns in developed countries. This study aims to identify the factors that influenced mortality and outcome of burns in Port Harcourt Nigeria.

Methods: Retrospective evaluation of data of patients with burns from January 1, 2007 to December 31, 2009 from a regional trauma registry in Port Harcourt Nigeria was undertaken and analysed. Factors observed to be associated with mortality and influenced outcome were determined and presented.

Results: The result of this study showed that of the 301 cases of burns were recorded during the period under observation. Flame burns arising from misadventure with petroleum products (n=188 {62.5%}) had the highest fatality especially when associated with inhalational injury (P <0.0001). The total burnt surface area was the greatest determinant of mortality from burns (R = 0.86,

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P<0.0001) and all the patients with burnt surface area above 50% died. The observed median lethal surface area of body burnt (LA50) from this study was 32%. Most of the deaths occurred during the first week of burns. The common complications which contributed to death observed during the early phase of burns was fluid and electrolyte derangement from inadequate and or over resuscitation (n=140).

Conclusion: The commonest determinant of fatality from burns was the total surface area burnt. Flame burns contributed to a sizable number of deaths especially when there is an associated inhalational injury. Most of the deaths occurred in the first week of admission from fluid and electrolyte derangements.

Keywords: Burns; burns mortality; outcome; outcome determinants; Port Harcourt; Nigeria.

1. INTRODUCTION

Burns injury has a global distribution and contributes to trauma mortality and morbidity [1,2,3]. Reports confirm a 50% to 150% decline in burn-related deaths and hospital admissions in the USA over the last 20 years [4,5]. Fifty percent mortality for burns covering 98% of total burnt surface area (TBSA) in children aged 14 years and under has been reported in the US [6]. Report confirms a median lethal area (LA50) for burns which is the total burnt surface area (TBSA) at which 50% of the victims died greater than 80% [3]. The LA50 provides a standard which enables comparison of outcome and care among various burn centres. An LA50 of 98% has been reported in children [7].

The observed reduction in the burns admissions and mortality in developed countries can be attributed to improved preventive measures, improved resuscitation and critical care, and better management of burn wounds [8,9]. The picture in most developing countries such as Nigeria and others in the sub-Saharan Africa is different and still depicts doom and gloom. The mortality and morbidity arising from burns injuries are still high. Reports from sub-Saharan Africa show that the LA50 is still within the range of 30% – 35% [2,10,11,12,13] which is the range observed in most developed countries during the early 1970s [8].

Delays in presentation [14] inappropriate care for burns, non-existent pre-hospital care [15], as well as inadequate facilities and available health care personnel with the requisite knowledge and experience in modern burns care [16] in most developing countries have been blamed for this poor outcome of burns. Burn care in Africa has been described as being hampered by inadequate facilities, inadequate infrastructure, and inadequately trained staff [17]. Some

persisting cultural beliefs and practices such as pouring raw egg on burn wounds, application of common salt on burnt skin, application of saps from special trees and herbs on burn wounds, application of palm kernel oil and even engine oils/ lubricants on burnt surfaces are still practised in the region. These practices have also been blamed as contributory to the poor outcome of burns in the region [18,19,20]. Other factors blamed for the observed poor outcome include poverty, overcrowding and ignorance which expose persons in the region to higher risk exposure to burns [19,21,22,23].

Flame burns have been reported to have overtaken scalds as the commonest type of burns in Nigeria [24,25]. Such flame burns usually result from explosions resulting from misadventure from petroleum pipeline vandalisation and adulteration of petroleum products. Burns resulting from such practices are often severe usually involve multiple casualties and are often fatal [24,25]. When such incident occurs at homes, the entire family is often involved. This may be attributable to overcrowding in few available small housing units often by large number of persons usually arising from the extended family practices in the region.

Apart from high mortality from burns, survivors of burns in most sub-Saharan Africa are left with much morbidity resulting from inadequate medical care. The survivors of burns leave in misery and discomfort with disabilities. Morbidity from burns contributes to the high disability adjusted life years (DALYs) lost to trauma in the region [22,23]. The psychological impact arising from loss of entire family and bread winners from such catastrophic incidents on the family, community and the wider society can only be imagined.

This study aims to determine the factors that are associated with mortality and influenced outcome

of burn injuries from a regional trauma registry in Nigeria.

2. METHODS

Data of burn injuries from a regional trauma registry involving different hospitals in Port Harcourt, Nigeria between January 1, 2007 and December 31, 2009 was retrospectively evaluated. Study was approved by the Management and the Ethical Review Committee of International Centre for Advanced Medical Care and Development (ICAMCAD) who are the developers of the registry. Since this study was designed as an observational survey without direct intervention or interaction with the patients, waiver for informed consent from the patients was obtained. However, patients' identity remained confidential throughout the study. Data of burns subset was extracted from the registry and analysed to establish the demographic pattern, treatment offered and outcome. The factors that contributed to death and influenced outcome was determined and highlighted.

Data was managed and analysed using the SPSS software version 15.0 for Windows (SPSS Inc. Chicago IL, USA). Descriptive statistics was generated and presented as averages for parametric variables, while proportions and percentages for categorical variables in tables. Chi square (X^2) and Fishers z test were used to test for statistical significance in observed differences between categorical variables whereas t-test was used to test for differences between means. *P* values less than 0.05 are accepted as significant. Outcome was stratified into good outcome if the burn wound healed within 6 weeks without any complications, fair outcome if the wound healed between 6 weeks and 3 months, with minimal complications and hospitalisation less than 3 months. Outcome was stratified as poor if the burn wound persisted after 3 months of admission, hospitalisation longer than 3 months or associated major complications such as abnormal wound scarring. Outcome was stratified as fatal if the patient died within 6 months as a result of the burns or direct complication of the burn injury. Associations between various variables and outcome including mortality were determined using Spearman's and Pearson's correlations as deemed appropriate. Correlation factor (*r*) closer to 1 is accepted as strong association between variables. Linear regressions analysis was done for strongly associated variables to ascertain the relationship and the best goodness of fit between the

variables. The LA50 was determined from the linear regression analysis as the TBSA where half of the victims died.

3. RESULTS

During the 3 years period under evaluation, a total of 301 cases of burns were recorded. Of the 301 cases, 196 (65%) involved males while 105 (35%) involved females, giving a male to female ratio of 1.9:1. The age distribution showed that majority of burns cases involved persons between the age group (20 – 39) years (191 {63.4%}) and by extension this age group contributed to the highest mortality. Children less than 10 years contributed 18% (n=54) of the cases while persons older than 50 years contributed 2.7% (n=8) (Table 1). Whereas the age group 21 to 40 years contributed the highest cases of burns and fatality, this age related distribution of burn fatality pattern was however not statistically significant. Persons older than 50 years presented the highest case fatality by age group. Pearson's correlation analysis showed a weak but significant correlation between age and outcome ($R = 0.152$, $P = 0.008$).

The commonest cause of burns was explosion from misadventure with petroleum products (n=167, {55.4%}) and contributed to the highest mortality. Road traffic collisions contributed 13% of the cases (n=39) (Table 2).

Flame burns was the commonest type recorded (n=188 {62.5%}) followed by scalds (n=48 {15.9%}) while 60 patients (19.9%) had associated inhalational burns (Table 3). Most deaths resulted from flame burns in enclosed environment and associated with inhalational injuries.

Sixty (20%) patients had associated inhalational burns of which 48 (80%) of such cases with inhalational burns were fatal ($X^2 = 41.14$, $P < 0.00001$).

The total burnt surface area (TBSA) calculated using the Wallace rule of Nines [26] showed that 94 patients (31.2%) had minor burns less than 10% TBSA while more than half of the patients (n= 156 {51.8%}) had severe burns with TBSA greater than 20%. The median interval to presentation from time of incident was 2 hours with range between 5 minutes to 2 weeks. Time to presentation was not a factor that influenced survival as the majority of the persons that died presented within 8 hours of injury ($P > 0.05$).

Table 1. Age distribution of burns and mortality

Age range (years)	Frequency	%	Fatality	Case fatality by Age group %
0 - 10	34	18	13	38.2
11 - 20	29	9.6	13	44.8
21 - 30	115	38.2	39	33.9
31 - 40	76	25.2	28	36.8
41 - 50	19	6.3	4	21.1
Above 50	8	2.7	5	62.5
Total	301	100	102	

$$\chi^2 = 1.36, P = 0.85$$

Table 2. Causes of burns and fatality

Cause	frequency	%	fatality	Case fatality %
Petroleum product explosion	167	55.4	91	54.5
Domestic accidents	51	17	5	9.8
Road traffic accidents	39	13	0	nil
Assault	13	4.3	1	7.7
Industrial accidents	8	2.7	2	25
Others	23	7.6	3	13.4
Total	301	100	102	33.9

$$\chi^2 = 66.9624, P < 0.00001$$

Table 3. Types of burns and case fatality

Type	Frequency	%	Fatality	Case fatality (%)
Flame	188	62.5	91	48.4
Scald	48	15.9	7	14.6
Friction burns	40	13.3	1	2.5
Electric burns	13	4.3	2	15.4
Others	12	4	1	8.3
Total	301	100	102	33.9

$$\chi^2 = 28.073, P = 0.000012$$

It was observed that all the patients were resuscitated using the Parklands formula [27] while burn' wounds were treated by repeated wound dressings and delayed split skin grafting (SSG) after the separation of the burns eschar. None of the patients had early wound excision and skin grafting. The median duration of hospitalisation of survivors was 19 days (inter quartile range {IQR} = 1 – 374 days) while median duration of hospitalisation for the patients that died was 8 days (IQR = 1 – 192 days) (Table 4).

Table 4. Duration of hospitalisation (LOS)

Median LOS for Dead Patients	8 days
Inter quartile Range (IQR)	1 – 192 days
Median LOS for Survivors	19 days
Inter quartile range	1 – 374 days

The common early complications observed included, fluid and electrolyte imbalance (140 {46.5%}), sepsis (n=120{39.9%}), multiple organ failure (n=70{23.3%}) while late complications

seen among the survivors included abnormal scarring (n= 40{20%}) and contractures (n=37{18.6%}) (Table 5).

Whereas the overall mortality was 34%, the case fatality showed that all the patients with TBSA greater than 50% died (Table 6). The highest determinant of death was the severity of burns expressed as the TBSA which determined the LA50 of burns. The calculated approximate LA50 was 32% (Fig. 1).

There was a strong association between the TBSA and fatality (Pearson's correlation $R = 0.86$, $P < 0.0001$). Linear regression analysis confirms strong relationship with high goodness of fit between TBSA and outcome, $R^2 = 0.65$, $P < 0.0001$ (Fig. 1).

4. DISCUSSION

This study showed that burns injuries present significant challenge and severe burns contribute to high trauma mortality and morbidity in

Port Harcourt Nigeria. Most deaths (98%) related to fire burns are in developing countries with Africa contributing about 25% [23]. This study confirms that the young adult males between 20 years and 40 years who are often the bread winners of their respective families and economic livewire of the nation were the most commonly affected. These age groups are more exposed to burn hazards and have the highest risk of burns and by extension mortality from burns. Whereas higher fatality was recorded amongst persons aged 20 years to 40 years, highest case fatality was observed amongst age group older than 50 years. This observed age related fatality amongst persons older than 50 years was not significant ($X^2 = 1.36$, $P = 0.85$). However, Pearson's correlation confirms a weak but significant association between age of the patients and outcome ($R = 0.152$, $P = 0.008$).

The reason for males between the ages of 20 years and 40 years being the most susceptible to death from burns is not farfetched; this age group are prone to higher risk taking especially in the locality and in Nigeria as a country because of harsh economic challenges and the desire to earn income by any means. The persisting high unemployment rate in Nigeria coupled with pressures from extended family responsibilities encourage young male adults to indulge in

various and occasionally hazardous means of earning income including misadventures with petroleum products. Explosions from such misadventure often result from unwholesome economic practises such as petroleum pipeline vandalisation, misadventures from burst petroleum pipelines and the use of adulterated petroleum products such as domestic kerosene [28,29,30].

The perennial shortage in the public power supply in Nigeria has led to the proliferation of electric generating sets at homes with attendant improper storage of petroleum products to generate power at homes. This has been fingered in the aetiology of domestic fire outbreaks and higher risk of burns injury [30]. There have been multiple incidences of burn disasters involving fallen or exploded trucks laden with petroleum products across the various parts of sub-Saharan Africa including Nigeria [15,16,30,31]. These situations often lead to flame burns which are usually severe and with often high fatality especially if there was an associated inhalational injuries. Agbenorku and colleagues showed that about 90% of patients with burns from petroleum related fire disaster had burns with TBSA greater than 30% [16]. Studies from other parts of Nigeria also confirm this pattern [2,24].

Table 5. Complications of burns

Complication	Frequency	%
Fluid and electrolyte derangement	140	46.5
Sepsis	120	40
MUltiple organ dysfunction and failure (MODF)	70	23.2
Amputation	7	2.3
Abnormal scarring	40	13.3
Contractures	37	12.3

Some patients had multiple complications

Table 6. Relationship between % TBSA and mortality

%TBSA	Nos	Fatality	Case fatality
<10	94	1	1.1
10 – 20	51	7	13.7
21 – 30	49	10	20.4
31 – 40	33	17	51.5
41 – 50	18	11	61
51 – 60	14	14	100
61 – 70	16	16	100
71 – 80	12	12	100
81 – 90	9	9	100
91 – 100	5	5	100
Total	301	102	

Regression Analysis for Burns Outcome

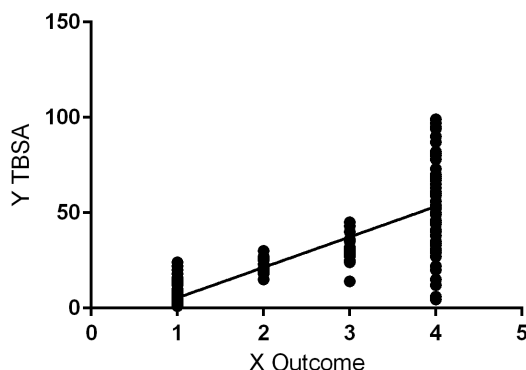


Fig. 1. Linear regression analysis between TBSA and outcome

Legends: Y axis = Percentage Total Burnt Surface Area (TBSA) expressed in %, X axis = Outcome of the patients

1 = good outcome, 2 = fair outcome with limited complications

3 = poor outcome with significant complications or hospitalisation longer than 3 months, 4 = fatal cases
Best-fit values: Slope 15.97 ± 0.6968 (95% CI = 14.60 to 17.33), Goodness of Fit: $R^2 = 0.6793$, $P < 0.0001$

Despite poorly organised pre-hospital care in Nigeria most of the patients arrived to the hospitals within 8 hours of injury especially when the burns is severe. Similar findings had been reported by other authors in various studies from the region [2,15]. This may be attributable to the public perception of burns episodes. Despite arriving within 8 hours of the incident, a good number of patients with severe injuries were among the persons that died. This implies that even early presentation did not influence mortality in this study.

The observed median duration of hospitalisation of 8 days among patients that died was indicative of the fact that a good number of these patients with significant burns may have died from inadequate resuscitation and inadequate intensive care [17,13] which is the period when fluid and electrolyte derangement is highest. This has been the common trend in burns death in sub Saharan Africa [32,33,34]. It has been postulated that burn patients “in Africa die of two general causes: early deaths as a result of burn shock or late deaths as a result of sepsis and multiple organ failure” [34]. It was observed that all the patients were resuscitated using Parkland formula. This is similar to findings from other centres around the country [18,19,20,21,22]. The limitations for the use of Parkland formula for resuscitation of major burns especially with the

concept of “fluid creep” and development of acute compartment syndrome has been well documented [35,36]. The reason for this practice may be related to relative non availability of colloids and other resuscitation fluids such as hypertonic saline required for other resuscitation protocols in the region. Even when such fluids are available the high cost of providing such fluids makes them out of reach of most patients and increases cost of burn care significantly. Since most patients are required to pay for their treatment, this puts significant financial burden on the family of the burnt patient who often is the bread winner in their homes. Until burns care is seen as a social responsibility well supported and funded by the government and other donor agencies, this pattern may continue to persist.

The case fatality showed a significant higher mortality in patients with burns with TBSA greater than 30% as compared to those with TBSA less than 30% ($p < 0.05$). In fact, all the patients with TBSA above 50% in this study died with the LA50 calculated at 32%. This is similar to other results from the country such as Enugu [13], Lagos [11], Zaria [2], and from other developing countries such as Ghana [16], Cote D'Ivoire [27], and India [37]. The LA50 from these studies are still in the region of 30% which is a far cry from the figures presently reported from the developed countries [2,3,5,9]. The decline in the mortality from burns observed in the developed countries has been attributed to implementation of effective prevention programs against burns [38], advances in pre-hospital care and improved hospital burns care with improved intensive care services early excision of burn wound and skin cover, and use of newer skin substitutes [5] in well equipped burn centres [34].

Apart from the recorded mortality, common complications recorded from this study include fluid and electrolyte imbalance, sepsis, multiple organ dysfunction and failure which are common contributors to the recorded high mortality. These complications were consequences of inadequate resuscitation and improper wound care. These factors contributed to the prolonged hospitalisation observed among survivors of severe burns. Other complications observed among survivors included wound contractures, scars and loss of function [5,33].

5. CONCLUSION

Burns is still remain a common problem in Port Harcourt Nigeria and contributes to trauma mortality in the region. Factors contributing to

burns mortality and poor outcome include severity of burns, flame burns with inhalational injuries and inappropriate burns care in the region. Early presentation to the hospital did not improve survival of patients with severe burns.

Since most deaths in this study occurred during the first week of incidents irrespective of time of presentation to the hospital which depicts inadequate or over resuscitation of fluids and electrolyte derangement, efforts should be tailored towards improving burn resuscitation in the region using validated protocols. In addition, widespread advocacy against storing of petroleum products at homes and desisting from tampering of petroleum pipelines should be undertaken as a way to prevent fire burn disasters in the region.

CONSENT

It is not applicable.

ETHICAL APPROVAL

Study was approved by the Management and the Ethical Review Committee of International Centre for Advanced Medical Care and Development (ICAMCAD) who are the developers of the registry.

AVAILABILITY OF DATA AND MATERIAL

The data that support the findings of this study are available from the authority of International Centre for Advanced Medical Care and Development (ICAMCAD) but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are however available from the authors upon reasonable request and with permission of the authority of International Centre for Advanced Medical Care and Development.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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