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Burn Mass Casualty Profile at the University of Calabar Teaching Hospital, Calabar, South - South Nigeria

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Abstract: Burn mass casualty is a clinical scenario describing a serious burn event with immediate threats to lives and/or public health. Burn mass casualty may occur due to a terrorist activity (intentional cause), semi-intentional (non-terrorist) or accidental cause. Usually, the burden of patient's inflow out-weighs the available infrastructure and man-power from a given incident. The objective of this study is to find out burn mass casualty profile in our institution and or State. The study was a three (3) year (2015-2018) retrospective review of major burn mass casualties in our institution. The study was carried out in the University of Calabar Teaching Hospital, Calabar. Records of all the burn injuries that presented at the A&E Department following burn mass casualty incidents within the stated period were retrieved and studied. Patient's folders, ward and theatre records of the patients were studied and analyzed. A total of one hundred (100) case notes were retrieved and analyzed. Five percent of the patients were females and 95 percent were males. The mean age ± (SD) was 31.6 ± (6.58) and mean %TBSA ± (SD) was 30.3 ± (10.0) The mean LOS (in weeks) ±(SD) was 7.2 ±2.39 and mortality was as high as 11 percent involving mostly the males. All the burn mass casualty incidents followed either unintentional (accidental) or semi-intentional causes. None followed intentional causes of burn mass casualty. In this center, the observed or documented etiological pattern was semi-intentional or accidental and not intentional as in terrorist activity. The implication is that the Public health model of injury prevention and control will be very appropriate for prevention campaign and management of burn mass casualty victims.

Key words: Burn injuries · Burn disaster · Petroleum tanker explosion · Industrial burns · Length of hospital stay

INTRODUCTION

Burn mass casualty (BMC) is a disaster and often not vis-visa. Burn mass casualty and burn's disaster are synonymous in context and management approaches but differ technically in definitions. BMC exist when the available facility and expertise is overwhelmed by the demand of care for a particular burn incident and at a particular time. Disaster, on the other hand, is a serious incident that posses immediate threat to Public health [1].

A burn disaster posses immediate threat to Public health and its it's characterized by events having seriously burned patients with a high morbidity and mortality rate [1, 2]. The management of BMC and / or burn disaster is quite delicate and challenging to health care providers, needing specifically trained Burn Surgeons and Burn Care providers. The BMC or burn disaster presents as a complex phenomenon requiring coordinated responses, involving deployment of resources and personnel. The nature of the complexity is such that the incident is associated with patterns or combination of complex trauma mechanism that may involve cutaneous burns, inhalational burns and other traumatic injuries which may be occult or overt. The management of the patients, the crowd and the entire scenario add up to the challenge especially in a resource constraint setting.

BMC may be due to natural occurrences or man-made activity. When BMC occurs the medical facility is often overwhelmed and the balance between the supply and demand of resources becomes overstretched and destabilized [1, 3].

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The events leading to BMC or burn disaster may follow either a natural occurrence or a man-made activity. The natural occurrences that may lead to BMC include lightening, thunder storms, arcs and flashes from non insulated high voltage transmission lines and conflagrations. While the man-made activities may be subdivided into: intentional acts, semi-intentional and unintentional (also accidental acts). The intentional activities include terrorist activities of all kinds, petroleum pipe line vandalization, military and civilian conflicts and arson. The semi-intentional activities and unintentional (accidental) causes somehow overlap. They include deliberate activities like stealing of petroleum products from accidented petroleum tankers and pipe lines which may lead to ignition, explosion with resultant BMC incident [4].

The unintentional or accidental causes are domestic cooking gas explosion, petroleum product explosions, industrial explosions and road traffic crashes among others [5, 6]. Many factors may determine the severity of BMC. These factors includes; the precipitating or igniting agent, the magnitude or quantity of inflammable agent and the number of people within the vicinity at the time of the incident. The morbidity and mortality of victims will be affected by the technical knowledge of first responders, mode of transportation to the nearest specialist care centre and the time spent from site of injury to the specialist center or tertiary institution and the source of affliction or provoking agent.

Notable events that resulted in BMC or Burn disaster were the Cocoanut Grove Night-club fire in Boston in 1942 and the United States of America terrorist attack of September 11, 2001; where the casualties sustained extensive cutaneous burns, inhalation injuries and other traumatic injuries [7].

In our country, the North East region had played host to the Boko Haram insurgency for the past 12 years (2009-2021), during which many of the insurgent activities had resulted in BMC or burn disasters with or without other traumatic injuries [8-10]. These terrorist used mostly locally fabricated explosives aimed at dense military or civilian populations in their bid to inflict maximum damages; a practice shared by designated terror groups all over the world [11, 12]. The question is why do terrorists like employing bombs?.

It is imperative therefore for the Burn or trauma surgeons and Burn care providers to have an understanding of the mechanism of injury and the pattern of injuries caused by these bombs. In the recent times, terrorist bombing has been on the increase in North-East region of our country; and this gives credence to a position held by some authorities stating that it will continue to be a difficult problem to handle even into the nearest foreseeable future [13, 14].

Most terrorist bombs are improvised explosive devices (IEDs) that cause a unique damage and pattern of injury. The bombs are of two types namely: the conventional bombs which are filled with chemical explosives and the dispersive type which are filled with chemicals and/or projectiles such as nails, sharp steel objects, pellets and other objects designed to disperse [14, 15].

The explosives are subdivided into: high order explosives (HE) and low order explosives (LE). The high order explosives produces a supersonic over pressurization shock wave which has a high damaging effect; generating temperatures as high as 3000°C from the explosive gases resulting in very fatal burn injuries and damage to other structures close to the point of detonation.

The low order explosives (LE) cause subsonic explosion which lacks the supersonic over pressurization shock waves effect. These explosives have specific features named [15-17].

Some authorities refer them as “manufactured” if they receive standard military certification, mass produced and had received quantity test approval and “improvised” if the weapons are produced in small quantities or its use is outside its intended purpose. The HE detonates more quickly and travels faster than the speed of sound while the LE reaction is slower and travels at a speed less than the speed of sound. LE involves deflagration, that is, rapid burning that gives of intense heat and sparks and not detonation.

Examples of HE include hand grenades, military bombs, dynamites, semtex fuel bombs. The LE includes gunpowder, air craft guided chemical missiles and other petroleum based explosives. All manufactured explosive weapons are exclusively HE. The terrorist tend to use whatever is available to them. Most often they obtain the manufactured weapons illegally and used them as IEDs. The combination of IEDs with highly combustible fuels, cooking gas cylinders and other volatile materials for terrorist bombs worsen the severity of damage and burn injuries in the targeted population [17-19].

When BMC occurs the burned victims are triaged and resuscitated. In our center, the Classical Medical Disaster Response (MDR) system of triage is often substituted for a more dynamic Simple Triage and Rapid Treatment (START) technique. This technique is coupled

with another system referred to as Secondary Assessment of Victim End point (SAVE). These methods of triage allow for triage over hours to days and direct limited resources to the subgroup of victims expected to benefit most from their uses [18-21]. Sometimes the "upside down" triage is done especially when the information of BCM or Burn disaster is received but the patients trickles in with the less severe case arriving before the very serious cases [20-22].

MATERIALS AND METHODS

The study was carried out at the Accident & Emergency Department of the University of Calabar Teaching Hospital, Calabar. Calabar, the capital city of Cross River State, is located in the South-South geo-political region of Nigeria. The University of Calabar Teaching Hospital is the dominant federal government-owned health facility in the State.

Study Population: The inclusion criterion was only burn victims from a particular incident leading to a Burn Mass Casualty incident. All burn victims from other causes presenting individually or in a set less than 10 burned victims from a particular incident were excluded from the study.

Data Collection: It was a retrospective study reviewing case notes of victims of Burn Mass Casualty between 2015 and 2018. The patient's secondary data including relevant demographic data, nature and venue of fire incident, percentage total body surface area (TBSA) affected by burns injury, length of hospital stay (LOS) and treatment outcome were collated for analysis. Treatment outcome was categorized into the following two options: Discharged home or death.

Data Management: The obtained data were initially entered into Windows 2010 version of Microsoft Excel spread sheet and thereafter exported to version 19 of the statistical package for social sciences (SPSS) software, for data analysis. Relevant tables were used to illustrate the results. Means and standard deviations were used to describe numerical variables; whereas simple proportions were used to present categorical variables. Chi-square and students t-test were used to compare categorical and numerical variables, respectively. Binary logistic and linear regression analyses were used to explore the predictors of mortality and length of hospital stay, respectively. The level of statistical significance was set at $p < 0.05$.

Ethical Consideration: This study was a retrospective study. It was not an experimental or interventional study and did not involve direct contact with the patients. However, all ethical issues were duly adhered to accordingly.

RESULTS

A hundred victims of Burn Mass Casualty were recorded during the period under study from 2015 to 2018. Fifty-six percent and 44% of the patients were victims of semi-intentional and unintentional fire incidents, respectively. None of the burn mass casualty patients was a victim of intentional (terrorist/ arson) fire incident. Forty-one percent of the subjects were within the 16 to 30 years age group; whereas, 58% and 1% of them were in the 31 to 45 years and 46 to 60 years age groups, respectively. The details of the study findings are as shown in the following tables:

DISCUSSION

A review of the literature reveals that the emphasis of most of the available studies on burn mass casualty was inclined towards the levels of preparedness and responses to burn mass casualties, outcomes of burn incident on patients, definitive care, length of hospital stay (LOS) and mortality rate of casualties involved; with little or no information on the aetiological pattern. This study is focused on the burn mass casualty (BMC) profile including pattern of aetiological presentation, length of hospital stay and outcome at the University of Calabar Teaching Hospital, Calabar South-south geopolitical region of Nigeria.

In this study, it was noted that the various causes of BMC include accidental and semi intentional causes. No intentional causes (arson or terrorist activities) were documented among the presentations. The age range of burn victims involved in BMC was 18 – 54 years. The mean age ± (SD) was 31.6 ± (6.58). Most of the victims of burn mass casualty in our centre were young men and women below 45 years of age. These were people in the very active and productive age bracket, possibly bread winners of their families. The necessity of venturing out to eke out a living from various walks of life exposes them to the heightened risk of various occupational hazards and other mishaps; providing a plausible explanation for the preponderance of people within the productive age bracket, among the burn mass casualty victims.

Table 1: Age and sex distribution and clinical characteristics of burns injury presentations

Variable	Female (%) (n= 5)	Male (%) (n= 95)	Total (%) (n= 100)	Test-statistic	P-value
Age (in years)					
Mean age ± SD	30.8 ±6.06	31.7 ±6.63	31.6 ±6.58	0.083	0.774
Median age	30	32	32		
Range	25 – 40	18 – 54	18 – 54		
Age group					
16 – 30	3 (60)	38 (40)	41(41)		
31 – 45	2 (40)	56 (58.9)	58 (58)	0.810	0.667
46 – 60	0 (0)	1 (1.1)	1 (1)		
Cause of Mass Burn casualty					
Petrol depot fire	2 (40)	54 (56.8)	56 (56)		
Sports centre fire	0 (0)	29 (30.5)	29 (29)	8.872	0.012
CBN fire 3 (60) 12 (12.6) 15 (15)					
%TBSA					
Mean % TBSA ±SD	17.2 ±2.59	31 ±9.77	30.3 ±10.0		
Median %TBSA	17	31	30.75	9.891	0.002
Range	14 – 21	13 – 70	13 – 70		
%TBSA category					
0 – 15	1 (20)	4 (4.2)	5 (5)		
16 – 30	4 (80)	39 (41.1)	43 (43)		
31 – 45	0 (0)	47 (49.5)	47 (47)	6.781	0.148
46 – 60	0 (0)	2 (2.1)	2 (2)		
61 – 75	0 (0)	3 (3.2)	3 (3)		
LOS (in weeks)					
Mean LOS ±SD	3.6 ±0.894	7.4 ±2.30	7.2 ±2.39		
Median LOS	3	8	8	13.240	0.000
LOS range	3 - 5	3 – 13	3 – 13		
Outcome					
Discharged home	5(100)	84 (88.4)	89 (89)	0.651	1.000*
Death	0 (0)	11(11.6)	11 (11)		

SD = Standard deviation; CBN = Central Bank of Nigeria; %TBSA = Percentage of total body surface area burned; LOS = Length of stay in the hospital

Table 2: Age of patients matched with causes of Burn mass casualty

Age group (years)	Petrol depot fire (%) (n= 56)	Sports centre fire (%) (n= 29)	CBN fire (%) (n= 15)	Total (%) (n = 100)
16 – 30	22 (39.3)	13 (44.8)	6 (40)	41 (41)
31 – 45	34 (60.7)	15 (51.7)	9 (60)	58 (58)
46 – 60	0 (0)	1 (3.4)	0 (0)	1 (1)

$\chi^2 = 2.874$; p= 0.579

Table 3: Percentage of total body surface area burned (%TBSA) matched with Causes of burn mass casualty

%TBSA	Petrol depot fire (%) (n= 56)	Sports centre fire (%) (n= 29)	CBN fire (%) (n= 15)	Total (%) (n = 100)
0 – 15	2 (3.6)	2 (6.9)	1 (6.7)	5 (5)
16 – 30	23 (41.1)	10 (34.5)	10 (66.7)	43 (43)
31 – 45	28 (50)	15 (51.7)	4 (26.7)	47 (47)
46 – 60	1 (1.8)	1 (3.4)	0 (0)	2 (2)
61 – 75	2 (3.6)	1 (3.4)	0 (0)	3 (3)

$\chi^2 = 6.462$; p= 0.596

Table 4: Predictors of length of stay in the hospital among burn mass casualty victims

Variable	B-coefficient	Stat	P-value
Age in years	0.193	2.858	0.005
Sex	-0.127	-1.866	0.062
%TBSA	0.762	9.340	0.000
Outcome (mortality)	-0.227	-2.930	0.004

%TBSA = Percentage of total body surface area burned

Table 5: Predictors of mortality among burn mass casualty victims

Variable	B-coefficient	Wald	p-value
Age in years	0.154	3.368	0.066
Sex	-16.294	0.000	0.999
%TBSA	0.321	6.614	0.010
LOS	-0.602	2.402	0.121

%TBSA = Percentage of total body surface area burned
LOS = Length of hospital stay

Majority of the burn mass casualty victims were males, yielding a male: female ratio as high as 19: 1. The observed male gender predilection is in agreement with the reports by some previous epidemiological studies of burns in Nigeria and the West African Sub-region [24-27]. The gender disparity in burn mass disasters is profoundly depicted by the outcomes of the Mass Burns Disaster from a petroleum pipeline explosion in Abule-Egba, a suburb of Lagos metropolis in South-western Nigeria and Mass Casualty from electrical burns injury at Makurdi, in the northern parts of Nigeria, where all the victims were males [28, 29]. Indeed, female victims constituted a small proportion of the patients in the index study; this female population is contributed by the female workers at the CBN and Petrol depot affected by fire incidents. The skewed pattern of gender distribution is not surprising as the men are more outgoing and adventurous in the traditional African setting. Moreover, the cultural and societal expectations place the burden of providing for the family on the male gender. It is noteworthy that negative vices and illegal activities by some of the victims were implicated in some of the disasters [4, 23, 28].

These semi intentional causes included activities such as the pilfering of petroleum products from accidented petroleum tankers and vandalization of petroleum pipelines to siphon the products for illegal sales [4, 23, 28]. These deliberate activities may become complicated by accidental ignition of fire resulting in burn mass casualty. The incident with the most casualties observed in this study was the petrol depot fire incident, a consequence of such illegal activities

The identified accidental causes of BMC were the industrial explosion at the regulatory bank parastatal in the state (CBN fire) and the sudden drop of an un-insulated high voltage transmission cable over the metallic roof top of a poorly constructed, local conference building used as a viewing centre for football matches from various European football leagues.

The victims in the case of Sports centre fire were mostly unemployed and under-employed young men who resort to gambling based on predictions of football match outcomes in order to generate incomes or those who could not afford television sets in their homes. These factors increase the appeal of watching these exciting foreign football matches in usually illegally-constructed, overcrowded, viewing centers. Again, the driving force here is poverty. The other factor is the negligence on the part of the Power Corporation that sited high voltage transmission lines very close to and, sometimes, over residential structures. This posed a potential hazard which ultimately led to loss of lives and properties during the fire accident. Also, implicated here is the poor maintenance culture and monitoring by government regulatory agencies. A systematic empowerment programme involving judicious provision of social services, prompt maintenance and monitoring of installations and education of the masses are imperative in the prevention of such mishaps.

Other clinical characteristics assessed in this study were the length of hospital stay (LOS) and mortality rate of victims. The length of hospital stay (LOS) is often predicted from the extent of body surface affected, at the rate of one day per percentage burned body surface areas. The actual LOS often exceeds the predicted LOS due to various factors. These factors include burn wound infections, other burn related complications, non-availability of appropriate or relevant medical facilities and lack of funds to procure needed medications. The latter factors are of relevance in our resource constrained setting in which access to needed health care services is further hampered by the absence of effective health insurance schemes whereby patients and their relatives resort to out-of-pocket payments in order to fund their treatments.

The estimation of LOS is relevant both in the early and late stages of BMC management. In the early stage, it helps in the counseling of the patients' relations. It also helps in appropriation of resources for treatment and feeding over the period. In the later stages, estimation of LOS helps the institution to canvass for support, plan for resource allocation, resource utilization and cost control in a resource constraint setting. In our study, the predictors of length of stay in hospital were age of the

patients in years, percentage total burned surface area (%TBSA) and outcome (mortality). The observation that outcome (mortality) had an inverse relationship with the length of hospital stay is not unexpected, as the death of patients naturally aborts their continued stay in the hospital. The strongest predictor was percentage total burned surface area followed by age in years and mortality of victims of BMC.

The findings of this study corroborate those of earlier investigators who identified the strongest predictors of length of hospital stay among burns patient to be patient's age and TBSA %burned, followed by full thickness burn %, female gender, inhalation injury, surgery including escharotomy and burn depth [33, 34]. However, sex was not established as a predictor in the index study.

This study identified the percentage of total body surface area burned (%TBSA) as the predictor of mortality among the victims of burn mass casualty. The high mortality noted in the study had a direct relationship to the extent and depth of burn injuries. It is important to note that the most significant predictor of mortality of victims of BMC was percentage total burned surface area (%TBSA). Some other studies that did not limit their focus to burn mass casualty, but looked at burn injuries in general, had noted %TBSA burned, age of the patient, cause of burn and inhalation injury as the factors that influenced patient mortality [32, 33]. The mortality in our study was made worse by the challenges of healthcare delivery in a resource poor environment and the factors were highlighted previously in the study.

CONCLUSION

MBC and Burn disaster presents a challenge to Burn Surgeons and Burn care providers and will continue to be on the increase. Most of the victims of burn mass casualty in our centre were young men and women below 45 years. The most significant predictor of mortality among victims of BMC was the percentage of total body surface area burned (%TBSA). Different regions or countries of the world are faced with different causal factors of BMC. Literature search revealed no significant report on the causal pattern of Burn Mass Casualty. In our institution located in the Southern region of Nigeria, this study revealed non-intentional and semi-intentional activities as the causes of burn mass casualty; with no records of intentional (arson or terrorist) fire events. Public enlightenment campaigns, provision of relevant infrastructures by the government and enactment of relevant legislations are critical steps towards the management and prevention of BMC in the region.

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