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Timing of death at National Trauma Center, Abuja, Nigeria

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Abstract

Background: ***We aimed to analyse the burden and timing of trauma deaths over a 1-year period at a trauma centre in Nigeria.***

Methods: ***This was a retrospective review of in-hospital trauma deaths during the period of January to December 2015. Sociodemographic data, cause of injury, mode of presentation, time interval between presentation and death, injury diagnoses, treatment, and place of death were analysed.***

Results: ***There were 2230 trauma consultations during the study period; 85 were brought in dead from the scene. We analysed data from 103 of 121 in-hospital deaths. Patient ages ranged from 0 to 90 years, with a mean age of 31.1. The male-to-female ratio was 5:1. Following injury, 46.6% of the victims presented directly to our tertiary centre, while 53.4% were referred from other hospitals. Most of the injuries were from RTA. Isolated head injury was the predominant diagnosis (44.7%), followed by polytrauma (29%). Immediate deaths (exclusive of those brought in already dead) comprised 5.8% of cases; 37.9% were early deaths and 56.3% were late deaths.***

Conclusions: ***The timing of trauma deaths closely approximated the original trimodal description in North America about half a century ago even though advances in trauma care have resulted in changes from this pattern in developed countries. Regionalised integrated care including prehospital trauma services are recommended.***

Keywords: trauma, mortality, timing

Introduction

In terms of years of productive life lost, prolonged or permanent disability, and economic costs, traumatic injury is an enormous public health problem throughout the world. Every day, about 16,000 people die from injuries, and for every person that dies, several thousand more are injured, many of them with permanent sequelae.[1] Injuries account for 16% of the global burden of disease, and it was estimated that about 5 million people die from injuries each year[2]; this is especially notable in low- and middle-income countries, with approximately 90% of the total burden of injury occurring in such countries.

In Nigeria, the annual report of the Federal Road Safety Corps in 2014 showed a total of 10,380 road crashes, which involved 16,779 vehicles and claimed 5996 lives with 32,063 persons injured.[3]

In a classic paper in 1983, Trunkey described a "trimodal" distribution of trauma deaths based upon the time interval from injury to death.[4] This represents 3 peaks of deaths following trauma, characterised as immediate, early, and late deaths. The first peak included immediate deaths, within the first hour after trauma, and contains about 45% of all deaths. The early deaths, within 24 hours following trauma, represented the second peak and accounted for about 34% of deaths.

The third peak, after the first 24 hours after trauma, accounted for about 20% of all deaths and represented the late deaths.[4,5]

Subsequent to this recognition, comprehensive trauma systems were developed to reduce the burden of injuries and trauma deaths by devising interventions to reduce all 3 types of trauma deaths.[6] Over the last 3 decades, these developments have included injury prevention, use of prehospital advanced life support interventions, rapid transport, widespread adoption of advanced trauma life support by prehospital providers and emergency departments, designated trauma centres with personnel and resources to care for the injured, evidence-based protocols for acute care of injuries, advances in critical care medicine, and multidisciplinary care of the injured.[7]

Analysis of the time and place of trauma death is useful in identifying areas that would benefit from improved treatment strategies, more focused research, education, and allocation of resources. The aim of this study, therefore, was to analyse the burden and timing of in-hospital trauma deaths in our trauma centre, over a 1-year period, to improve further care for the patients.

Methods

Setting

The National Trauma Center is an 80-bed facility within the National Hospital, Abuja. All major injuries are resuscitated at the 8-bed resuscitation area, with facilities for ventilation and life-saving procedures. There is a trauma team consisting of a trauma fellow, a senior registrar, surgical registrars, and trauma nurses on 24-hour cover for all major resuscitation and life-saving surgeries. There are 2 major theatres and an 8-bed burns unit with barrier nursing capacity. There is an 8-bed intensive care unit (ICU) for critical trauma patients, which is managed by anaesthesiologists. Full radiological services, including computerised tomography, as well as laboratory and blood transfusion services, are accessible 24 hours per day.

Routine protocol care at the trauma centre

All patients that present to the trauma centre are seen at the triage and all with major injuries and those referred are taken to the resuscitation area. Resuscitation is done according to the Advanced Trauma Life Support (ATLS) guidelines by the trauma team. There is a full complement of other surgical teams—neurosurgery, orthopaedics, cardiothoracic, paediatric surgery, and plastic units—for further management of stabilised patients. For patients that require intubation, this is by anaesthesiology unit on trauma call.

Study design

This was a 1-year retrospective analysis of all patients that died at the trauma centre from 1 January 2015 to 31 December 2015. All patients who died from trauma, including burns, were included.

All data were extracted from the patient files. Recorded sociodemographic variables were age, sex, marital status, ethnic group, occupation, and residential address. Note was also made of who conveyed the patient from the scene of injury to the hospital. History of the event, time and place of the incident, time interval before presentation to hospital, duration of hospital stay, mechanism of injury, and cause of injury were also recorded.

The vital signs taken at the beginning of resuscitation and the Glasgow Coma Score (GCS) were recorded. The diagnoses, treatment given and cause of death were all recorded in the pro forma. Patients who died from blood loss and ensuing hypovolaemic shock were adjudged to have died from exsanguination, while those who died from the primary consequence of traumatic central nervous system (CNS) injury were termed CNS mortality. The patients with progressive multiple organ dysfunction and subsequently died of multiple organ failure (MOF) were identified as such, while patients with burns and sepsis from the wound focus were labelled as deaths from burn wound sepsis.

Data management

The individually completed data collection forms for each patient were entered into Epi Info version 3.2.2. Results were expressed as means and standard deviations or medians with ranges. The chi-square test was used to check for associations where appropriate. A P-value ≤ 0.05 was considered significant.

Ethical approval

Ethical approval to carry out the study was obtained from the hospital's institutional review board.

Results

During the study period, 2230 injured patients presented to the trauma centre, of which 1774 required admission. There were 121 in-hospital trauma deaths, of which adequate records were available for 103 patients, and these were included in the analysis. Eighty-five patients were brought in dead and were excluded.

Table 1: Age and timing of death

Age	Immediate n (%)	Early n (%)	Late n (%)	Total n
0-9	-	3 (37.5)	5 (62.5)	8
10-19	-	4 (57.1)	3 (42.9)	7
20-29	3 (8.8)	12 (35.3)	19 (58.9)	34
30-39	3 (9.4)	8 (25)	21 (65.6)	32
40-49	-	9 (75)	3 (25)	12
50-59	-	1 (16.7)	5 (83.3)	6
60-69	-	1 (50)	1 (50)	2
70-79	-	-	2 (100)	2
80-89	-	-	-	
90-99	-	1 (100)	-	1
Total	6	39	59	103

Demographics

Patient ages ranged from 0 to 90 years, with a mean age of 31.1. Sixty-four percent of patients were in the 20- to 39-year age group. No statistically significant relationship was found between age and timing of death (Table 1).

Most of the mortalities occurred in the male patients (n = 86; 83.4%), with a male-to-female ratio of 5:1.

Students, traders, and unemployed individuals accounted for most of the occupational groups among the deaths, with 16 (21%), 15 (19.7%), and 14 (18.5) individuals identified by these labels, respectively. Skilled trade professionals, such as farmers, drivers, and mechanics, together accounted for 12 (15.8%) of the deaths. There were 11 civil servants and 5 of the victims were policemen.

Injury presentation

There was marked variability in the months of mortality. Seventeen patients (16%) died in July, representing the highest in the series, while 4 (3%) presented in each of January and September, representing the lowest monthly total. Fourteen (13%) and 12 (11.6%) patients died in November and December, respectively.

Following their injuries, 48 (46.6%) of the victims presented directly to the trauma centre, while 55 (53.4%) were referred from other hospitals.

Among the referred patients, 37 (67.3%) were from hospitals within the Abuja Municipal Area Council, 26 were from 10 different general hospitals in the larger Federal Capital Territory (FCT-Abuja), 5 patients were from Federal Medical Center Jabi, 4 were from private hospitals, and 1 patient was from the State House Clinic. The remaining 18 (32.7%) of the referred patients were from the neighbouring states of Nassarawa and Niger, with 12 and 5 patients, respectively. One patient was a victim of bomb blast and was referred from Yobe State.

Forty-seven (85.5%) of the referred patients were brought by ambulance for the interhospital transfer. Eight patients were brought to the trauma centre by other means.

Table 2: Mode of presentation and timing of death

Mode of transport	Immediate n (%)	Early n (%)	Late n (%)	Total n
Ambulance	-	14 (29.8)	33 (70.2)	47
Police	4 (25)	6 (37.5)	6 (37.5)	16
NEMA	-	4 (66.7)	2 (33.3)	6
FRSC	1 (25)	1 (25)	2 (50)	4
Private	1 (4.8)	7 (33.3)	13 (61.9)	21
Public	-	6 (60)	4 (40)	10

$X^2 = 11.0059$, P = 0.026, significant at P < 0.05; NEMA = National Emergency Management Agency; FRSC: Federal Road Safety Corps

The patients who presented directly to the trauma centre were mostly brought by private cars (n = 21; 37.5%). Police in their patrol pick-up vans brought 16 patients (28.6%). The National Emergency Management Agency (NEMA) (n = 5; 8.9%), the Federal Road Safety Corps (FRSC) (n = 4; 7.1%), and public transport (n = 10; 17.9%) were other transportation means that brought trauma patients directly to the centre during the study period. There was a statistically significant relationship (P < 0.05) between the method of transport and timing of death (Table 2).

Mechanism and injury diagnosis

In terms of mechanisms of injury, road traffic accidents (RTA) injuries (n = 65; 63.1%) were most common. There were 18 burns (17.5%), 2 of which were RTA-associated. Eight injuries (7.8%) were from stab wounds and mob beatings, 5 (4.9%) were gunshot wounds, 3 were from falls, and 3 were categorised as "other". There was no statistically significant relationship between mechanism of injury and timing of death (Table 3).

Table 3: Mechanism of injury and timing of death

Mechanism	Immediate n (%)	Early n (%)	Late n (%)	Total n (%)
RTA	6 (9.2)	23 (35.4)	36 (55.4)	65
Assault	-	5 (62.5)	3 (37.5)	8
GSW	-	3 (60)	2 (40)	5
Burns	-	5 (26.3)	14 (73.7)	19
Falls	-	1 (33.3)	2 (66.7)	3
Others	-	2 (66.7)	1 (33.3)	3
Total	6	39	58	103

X^2= 4.1422, P = 0.39, not significant at P < 0.05; RTA = road traffic accident; GSW = gunshot wound

Among the RTAs, pedestrian injuries were most prevalent (n = 27; 41.5%); 24 pedestrians were hit by cars and 3 were hit by motorcycles. Fifteen patients (23.1%) were motorcycle riders, with 2 motorcycle collisions, 8 motorcyclists hit by cars, and 5 patients fell from their motorcycles. Fourteen (21.5%) of the injuries were from automobile accidents: 5 patients each were from single-car losses of control and collisions between 2 cars. Four patients were injured during accidents caused by burst care tires.

Nine RTAs (13.8%) involved 2 patients falling from a trailer on the back of a truck. Two patients were injured in a trailer that hit a bus. Three patients were from a bus that hit a stationary truck, 1 patient was injured when a trailer hit a car and, and 1 when a trailer hit a motorcycle.

Isolated head injury was the commonest injury diagnosis, accounting for 46 cases (44.7%). Thirty patients (29.1%) sustained multiple injuries. There were 4 (3.9%) abdominal and spinal cord injuries each, and 1 patient with bilateral femoral fractures. Twenty-seven (90%) patients with head injuries were among the 30 patients who had multiple injuries.

Thirty-five patients (34%) were fully conscious (GCS 15/15) at presentation. Twenty-two patients had a GCS of 3/15, which was the most common score among those with GCS < 15/15. Forty-five (61.6%) of the patients diagnosed with head injury had severe head injuries, with a GCS between 3/15 and 8/15; 18 patients (24.7%) had moderate head injuries, with a GCS between 9/15 and 12/15, and 10 patients (13.7%) had mild head injuries.

Thirty-nine patients were intubated, 35 of whom were diagnosed with severe head injuries. Quadriplegia and aspiration were the other indications for intubation; both of these diagnoses being applied twice.

Twenty-one patients (20.4%) underwent surgery, half of which were craniotomies for haematoma evacuation. Four patients underwent laparotomy for abdominal injuries, 2 patients underwent tracheostomy, and 2 patients underwent laminectomy.

Cause, timing, and place of death in the hospital

Fifty-seven deaths (55.3%) were secondary to head injury, but only 8 patients were brain dead on a ventilator. Twelve patients (11.7%) died from exsanguination, 11 (10.8%) died from multiple organ failure (MOF), and 13 (12.6%) died from burn wound sepsis. Ten patients (9.7%) died of respiratory failure, and 1 patient died of suspected pulmonary embolism.

Table 4: Cause and timing of death

Cause of death	Immediate n (%)	Early n (%)	Late n (%)	Total n
Exsanguination	1 (16.7)	5 (12.8)	6 (10.3)	12
CNS	5 (83.3)	23 (59)	29 (50)	57
MOF	-	4 (10.3)	7 (12.1)	11
Respiratory failure	-	7 (17.9)	1 (1.7)	8
Burn wound sepsis	-	-	14 (24.2)	14
Others	-	-	1 (1.7)	1
Total	6	39	58	103

CNS = central nervous system trauma; MOF = multiple organ failure

Thirty-seven patients (35.9%) died in the trauma resuscitation area, 36 (35.0%) died in the trauma ICU, 15 (14.6%) died in the ward, 14 (13.6%) in the burns unit, and 1 patient died in the radiology suite.

There were 6 (5.8%) immediate trauma deaths in the series (those occurring within 1 hour of arrival to the trauma centre). Thirty-nine (37.9%) early deaths occurred (within 24 hours of arrival), along with 58 (56.3%) late deaths (all in-hospital deaths after the first 24 hours). The duration of hospital stay for the late deaths ranged from 1 to 104 days, with a mean hospital stay of 16.5 days.

Discussion

Demographics

RTAs have been found to have increased incidence in Nigeria around the so-called "ember months" of October, November, and December,[8] likely because of increased rates of travel and festivities; however, mortality at the National Trauma Center in Abuja was found to be highest in July. In a study of temporal patterns of trauma deaths in Scandinavia by Soreide,[9] trauma deaths were found to occur with some monthly variance, as demonstrated by 2 monthly peaks in February/March and July/August, respectively. Overall, they did not find any statistically different seasonal differences in the occurrence of traumatic deaths, nor any differences in cause of death, type or severity of injury, nor in physiological parameters.

The majority of deaths at our trauma centre during the study period were among young individuals, with 64% between the ages of 20 and 39 years. Similar observations were made in other studies.[2,5,10–12] Even though mortality for a comparable injury severity is higher at the extremes of age,[13,14] there was no statistically significant relationship between age and timing of death in our study.

Individuals from the low-income group were most affected by the fatal injuries; this is similar to other studies from Africa.[11,12] Although commercial motorcycle use and street vending are outlawed in the Federal Capital, there is still widespread engagement that may account for the high rate of pedestrian and motorcycle injury. In addition, at trauma centre registration relatives may not readily admit street vending or commercial motorcycle use as an occupation, preferring to report something like "trader" or "unemployed". Apart from the increased risk of injury, low-income individuals have less capacity to pay for care and thereby add to the socioeconomic burden on their families.

The study found a significant gender disparity, with most injury mortality occurring in males. Generally, men are more likely than women to die of almost every disease and illness and to die earlier. Injury, a leading cause of premature death, is no exception.[15,16] Men's higher unintentional injury, suicide, and homicide mortality rates are observed in all age groups in low-, middle-, and high-income countries.[17] The sole exception is for homicide of children under the age of 15 years in low- and high-income countries, where the rates for girls are similar to or higher than those for boys.

Injury presentation

Prehospital and transport services were only involved in the transfer of patients from the scene of injury in about 16% of cases. However, ambulances were utilised in most interhospital transfers. Police vehicles—as well as private and public transport—were utilised in most cases.

There was a statistically significant relationship between the mode of presentation and timing of injury, with most immediate and early deaths occurring in those brought to the trauma centre by rescuers (police, FRSC) and the late deaths occurring in those patients brought by interhospital transfer ambulances.

The widespread referrals from the 10 general hospitals within the Abuja Municipal Area Council would be a trauma service asset in an inclusive system. It would allow for the assessment and stabilisation of trauma patients before transport to the trauma centre (if indicated) and allow for the less severely injured patients to be cared for within their communities. Inclusive systems have been found to be associated with decreased injury-related mortality compared to exclusive systems in which dedicated trauma centres and prehospital bypass mean that severely injured patients are not transported to the closest facilities but to trauma centres. This focus of transport and definitive care facilities, though simple, has been shown to be associated with a significant reduction in preventable trauma deaths.[18]

Mechanism of injury

RTAs accounted for the highest number of injuries, which is in keeping with other studies in Nigeria.[10–12] This differs from the finding in the USA, that falls, RTAs, and firearm injuries are each responsible for an almost equal percentage of deaths (16-17%).[19] In our study, there was no significant relationship between mechanism and timing of death.

Among the RTAs in this study, those in which pedestrians were struck by vehicles were the most common; this differs from other findings in Nigeria,[20–22] where motorcycle injuries often predominate.

Cause of death

Our study findings are consistent with others that have shown traumatic brain injury and haemorrhage as the predominant cause of death in trauma patients.[4,6,10,11] Additionally, studies from Nigeria have shown challenges with airway management in patients with severe head injuries. Half of all the surgeries carried out during the period under study were craniotomies for haematoma evacuation. Only 13% of the patients with head injury required surgery. This can be considered a success of the dependable availability of immediate resuscitative services and critical care at our centre. Monitoring and treating intracranial pressure (ICP) and quantifying cerebral perfusion pressure (CPP), cornerstones in the management of severe traumatic brain injury,[23] were not utilised, perhaps due to cost limitations.

MOF has been described as a disease of medical progress, because as technological advances in critical care improve survival, patients develop complications of critical illness that were not previously seen. It is estimated MOF plays a role in up to 80% of ICU deaths.[24,25] Durham et al., in their study of MOF in trauma patients, found that 52.3% patients died with MOF, while 4.2% had single organ failure (SOF) and that all SOF was respiratory failure.[26]

Timing of death

The immediate deaths, which represent the first peak of trauma mortality, accounted for 48.4% in this study. By comparison, 64% of the deaths were immediate in the original 1972 study.[4] A later study in the US found 53% of trauma deaths to be in the immediate category.[6] Recognition of the extent of these immediate deaths led to rapid development of regionalised integrated trauma systems in North America.[5,7] The purpose of these systems has been to facilitate injury prevention services, prehospital trauma care, and rapid transportation from the scene of injury to definitive care facilities.

Over the years many countries have developed systems for providing emergency and trauma medical care. This prehospital care is provided by professional rescuers, who are the first officials to reach the scene, often with an ambulance equipped to render advanced prehospital trauma care. This care is manifested through assessment and interventions, such as intravenous fluids, endotracheal intubation, needle decompression, and cricothyroidotomy. Transportation is then provided in a large ground or air ambulance that is equipped with sophisticated monitoring devices, a wide range of medicines, and an array of communication devices.[27] These are expensive arrangements that are unlikely to be available to resource-constrained environments. However, Prehospital Trauma Care Systems[28] is a publication developed by the World Health Organization (WHO) that focuses on the most promising interventions and components of prehospital trauma care systems. The manual particularly focuses on interventions that require minimal training and relatively little in the way of equipment or supplies to form the foundation of the emergency care system, regardless of the level of resources available. This could form the groundwork of prehospital trauma care in our environment, with scarce resources.

Early deaths, representing the second peak of trauma mortality, accounted for 21% of deaths at our centre during the period under study; this is comparable to the 25% to 30% elsewhere.[4,6] These deaths are a consequence of severe injuries, but the patients present alive and are potentially treatable with prompt resuscitation and definitive care. The services of protocol-based care, best practices guidelines, ATLS, massive blood transfusion services, advances in haemostasis, investigations, damage control surgeries, and specialist trauma services are all directed at saving patients in this category.[29–31]

Late trauma deaths, representing the third peak, typically occur days to weeks after initial injury in those that survived the initial insult. This study found 30% of the trauma deaths belong to this category, which is in contrast to 20% described in the original study.[4] Advances in critical trauma care—including investigations, monitoring, and organ system support—should result in improved outcomes in this category of patients.[29] These improvements in care have resulted in the majority of patients outside the extremes of age treated in a modern burn centre being expected to survive.[32] The US national burn repository, with reports submitted from 91 hospitals, showed that the length of stay has reduced in the past 10 years from approximately 11 days to 9 days, and mortality has fallen in females from 6.8% to 3.6% and in males from 4.5% to 3%.[33] The mean duration of hospital stay from our study was 16.5 days.

The establishment and maintenance of a trauma system are expensive, even in the developed world.[34] The Essential Trauma Care (EsTC) Project is a collaborative effort of WHO and the International Society of Surgery to identify and promote inexpensive ways of reinforcing trauma treatment worldwide, through the development of low-cost activities, ranging from surveillance and basic research, to prevention programmes, to trauma management.[35] In this regard, The EsTC Project has served as the basis for needs assessments made in Vietnam, India, Mexico, and Ghana.[36]

Good clinical trauma care and effective injury prevention programmes are necessary to reduce death and disability from injury. This has been the foundation for a trauma system based on the concept that injury as a disease can be prevented or have its negative impacts decreased by primary, secondary, and tertiary prevention,[5,6] through interactions with agencies, institutions, and systems.

Conclusions

The timing of trauma deaths at National Trauma Center, Abuja, closely approximates the original trimodal description in North America about half a century ago even though advances in trauma care have resulted in changes from this pattern in developed societies.

Severe traumatic brain injury in young men referred from other hospitals following road traffic accidents predominate as the cause of death, with most of them intubated at the trauma centre resuscitation area and eventually dying at the trauma ICU.

Regionalised integrated trauma care, including prehospital services using low-cost essential trauma service guidelines, are recommended, in addition to further trauma research in our environment.

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