

## CARDIOTHORACIC SURGICAL EMERGENCIES IN A NIGER DELTA TERTIARY HEALTH INSTITUTION: A 12 MONTH APPRAISAL.

*E. E. Ekpe FWACS, T. Nottidge FWACS, O. E. Akaiso FWACS*

*Department of Surgery, University of Uyo Teaching Hospital, Uyo, NIGERIA.*

### **Abstract**

**BACKGROUND:** Many cardiothoracic surgical emergencies maybe life threatening. More than 70% of these are caused by thoracic trauma. Fortunately about 85% of thoracic trauma may be optimally treated with closed tube thoracostomy drainage (CTTD) or lesser procedures. A well dedicated trauma / cardiothoracic surgical unit is needed to significantly reduce the death toll from thoracic trauma.

**OBJECTIVE:** This study aimed to audit the cases of cardiothoracic surgical emergencies that presented to, and were managed in the University of Uyo Teaching Hospital over a one-year period in order to provide a database prior to a formal setup of a cardiothoracic surgery unit.

**STUDY DESIGN:** Clinical records of all patients with cardiothoracic surgical emergencies who presented during the period under review were analyzed.

**RESULTS:** There were 54 patients with cardiothoracic surgical emergencies during the period with male: female ratio of 2:1, and mean age of 30 years. Eighty-five per cent had thoracic trauma and 15% had major peripheral vascular injury. Thirty-five (64.8%) of the patients were treated in our hospital with medications and additional closed tube thoracostomy drainage in 51.9%. The remaining 35.2% of the patients were referred to cardiothoracic centre / units in other states over a range of 80 to 300 km away from Uyo, Nigeria.

**CONCLUSION:** Our findings conform to the known epidemiological pattern of cardiothoracic surgical emergencies, and emphasize the urgent need for a functional / well equipped cardiothoracic surgical unit in our hospital.

**KEYWORDS:** Cardiothoracic emergencies, need for a cardiothoracic unit

### **INTRODUCTION:**

Many cardiothoracic surgical emergencies are life threatening. About 70% are caused by trauma, and about 50% of trauma related deaths have thoracic components. About 85% of thoracic injuries are optimally treated by closed tube thoracostomy drainage (CTTD) or lesser procedures.<sup>1</sup>

Uyo is the capital of Akwa Ibom State, in the Niger Delta region of South-South geographical zone of Nigeria with a high patronage of commercial motorcycles as means of both inter- and intra- city transportation. This increases the risk of road traffic accident (RTA).

This study aimed at auditing cardiothoracic surgical emergencies in the hospital in the previous one year to serve as database for the proposed cardiothoracic surgical unit.

### **MATERIALS AND METHODS**

This is a retrospective study that covered the period October 2005 to September 2006. Case notes of all patients who presented with cardiothoracic surgical emergencies were retrieved. Their demographic data, mode of presentation, clinical features, investigations, treatment, and outcome were reviewed. The information was entered into a proforma and analyzed using EPI INFO version 2000.

### **RESULTS**

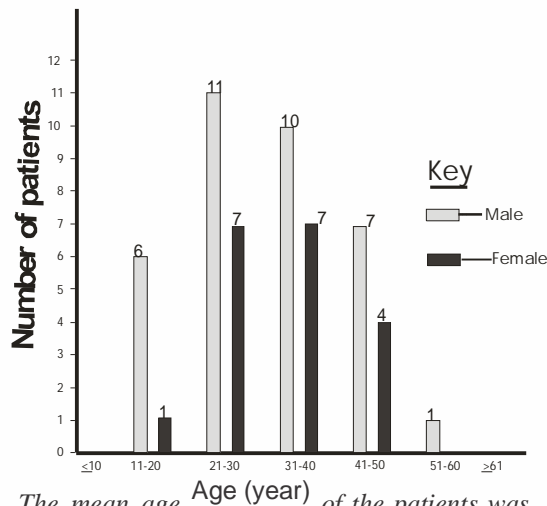
In the 12 month period, October 2005 September 2006, a total of 54 patients were seen with cardiothoracic surgical emergencies distributed as 35

*Correspondence:* E. E. Ekpe Department of Surgery, University of Uyo Teaching Hospital, P.M.B. 1136, Uyo, NIGERIA.

*E-mail:* docekpe@yahoo.com *Phone #:* +234 803-487-5889

males and 19 females (male: female ratio 2: 1). The mean age of the patients was 30 years with a range of 12 to 57 years (fig. 1). There was no patient in the

**Figure 1: Age/Sex Distribution**



The mean age of the patients was 30 with range of 12 - 57 years. The male preponderance was present in all age groups

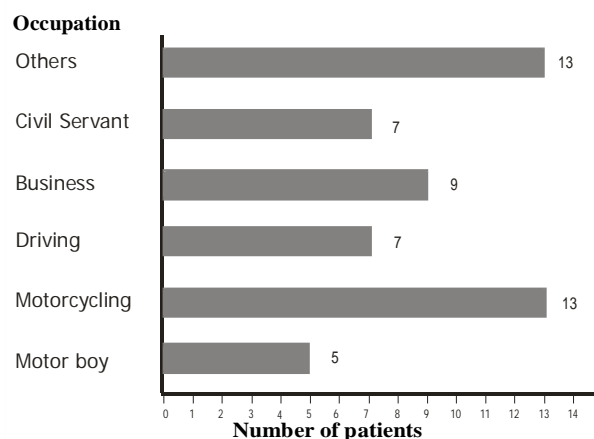
first decade of life and none beyond the fifth decade of life. Motorcyclists accounted for 13 (24.1%) of the patients, while drivers accounted for 7 (13.0%). Civil servants were 7 (13.0%), business people 9 (16.7%), motor boys or conductors 5 (9.3%). Others included pupils, students, politicians, touts, clergies, and craftsmen who accounted for the remaining 13 (24.1%) (fig. 2).

Road traffic accidents including vehicular-pedestrian injuries were the mechanisms of the injury in 31 (57.4%) patients, assaults including gunshot by police, armed robbers, cultists and assassins, and machete cut, and blow with various objects like stick and concrete block, were responsible for injury in 14 (25.9%) of the patients with chest penetration in 5 patients (9.3%), soft tissue lodgement of bullet or pellets in 6 (11.1%) patients, and limb vascular injury in 2 (3.7%) patients. Other mechanisms of injury were fall from height in 3 (5.6%), hit by falling object

1 (1.9%), iatrogenic injury to the femoral vessels during femoral herniorrhaphy and groin dissection in two (3.7%) patients (fig. 3).

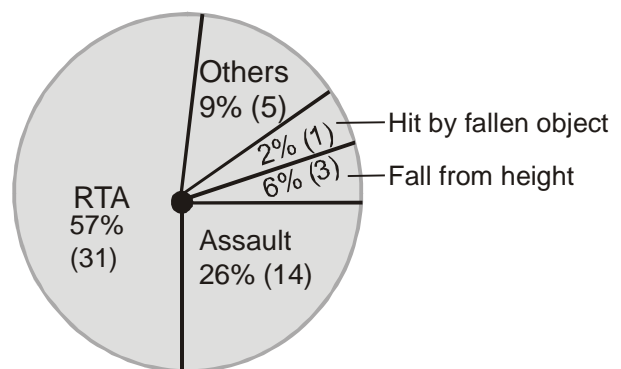
Most patients 40 (74.1%) presented primarily while 14 (25.9%) presented on referral after initial presentation to private or general hospital(s). All patients who presented after 24 hours of injury had been taken to another hospital before presentation in our hospital. The majority of patients 35 (64.8%) were stable at presentation while the unstable ones

**Figure 2: Distribution of Patients by Occupation**



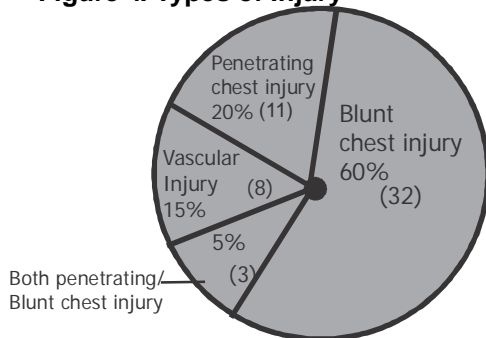
Motorcyclists were affected more than other group. The heterogeneous group tagged other included students, clergies and craftsmen. The motor boys were conductors who traveled with drivers.

**Figure 3: Distribution of Patients by Mechanism of Injury**



Road traffic accident accounted for 57.4% of the injuries, followed by assault (25.9%) which included gunshot wounds, machete cuts and blows. Amongst the others were two (3.7%) who sustained iatrogenic injury to the femoral vessels during femoral herniorrhaphy and groin dissection respectively.

**Figure 4: Types of Injury**



Thirty-two (59.3%) of the patients had blunt chest injury, 11 (20.4%) had penetrating chest injury, and 3 (5.6%) had both blunt and penetrating chest injury. The remaining 8 (14.8%) had major vascular injury.

**Table I: Approximate Distance from Site of Injury to the Hospital**

DISTANCE in Mile (Km)	NO. OF PATIENTS (%)
<35 (56)	40 (74.1%)
35 – 70 (56 – 112)	10 (18.5%)
>70 (112)	4 (7.4%)
<b>TOTAL</b>	<b>54 (100%)</b>

Up to 74.1% of the patients had their injury within 35 miles from the hospital, another 18.5% between 35 to 70 miles while 7.4% sustained their injuries over 70 miles from the hospital

who needed intensive resuscitation were 19 (35.2%). Blunt or closed injury was the type of injury in 32 (59.3%) of the patients, while penetrating chest injury and a combination of both blunt and penetrating chest injuries occurred in 11 (20.4%) and 3 (5.6%) of the patients respectively. Major vascular injury needing revascularization operation occurred in 8 (14.8%) of the patients (fig. 4).

Table I shows that 40 (74.1%) of the patients sustained their injury within 35 miles (56 km) from the hospital, 10 (18.5%) between 35 to 70 miles (56-112 km) and 4 (7.4%) beyond 70 miles (112 km). Only 24 (44.4%) of the patients presented within one hour of their injury, 17 (31.5%) between one to six hours, 6 (11.1%) between six and 24 hours, and 7 (13.0%) presented beyond 24 hours (table II). Lung parenchymal injury resulting in haemothorax or haemo-pneumothorax was the commonest type of injury (59.3%), followed by rib fracture (40.7%). Mediastinal injury and major airway injury occurred in 3.7% of the patients each. Extra-thoracic vascular

**Table II: Time Lapsed Between Injury and Presentation in Hospital**

DURATION (in Hour)	NO. OF PATIENTS (%)
< 1	24 (44.4)
1 – 6	17 (31.5)
6 – 24	6 (11.1)
> 24	7 (13.0)
<b>TOTAL</b>	<b>54 (100)</b>

Only 44.4% of the patients presented within one hour of injury, 31.1% between 1 – 6 hours, 11.1% between 6 – 24 hours and 13.0% presented beyond 24 hours.

injuries including major arterial injury demanding immediate revascularization operation for limb salvage, and minor arterial, venous, and veno-arterial injuries occurred in 27.8% of the patients as a whole (table III). Figure 5 shows that 17 (31.5%) of the patients sustained injuries classified amongst immediate treatable causes of death which need immediate diagnosis and prompt / proper treatment

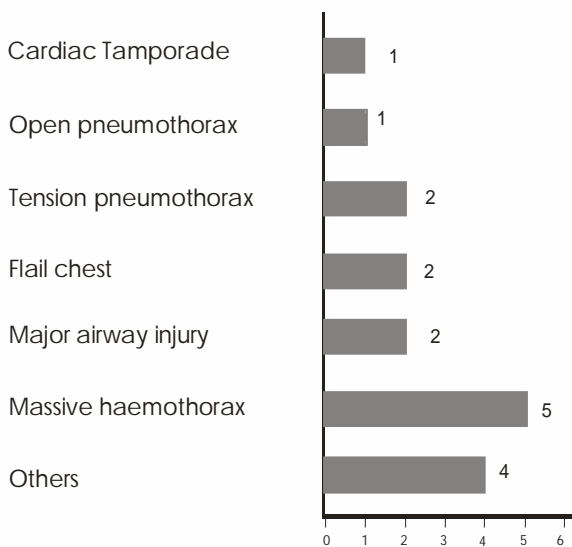
**Table III: Classification of Injury**

INJURY	NO. OF PATIENTS (%)
Haemo-pneumothorax	32 (59.3%)
Rib fracture	22 (40.7%)
Others	15 (27.8%)
Major airway Injury	2 (3.7%)
Mediastinal Injury	2(3.7%)
Diaphragmatic rupture	- - - -

Haemo-pneumothorax (59.3%) was the commonest type of injury sustained, followed by rib fracture (40.7%). Other types of chest injury were major airway injury (3.7%) and mediastinal injury (3.7%). Vascular injury including both major and minor ones occurred in up to 27.8% of the patients. Some patients sustained more than one type of injury.

to prevent death; cardiac tamponade in 1 (1.9%), open pneumothorax in 1 (1.9%) tension pneumothorax in 2 (3.7%), flail chest in 2 (3.7%), major airway injury in 2 (3.7%) and massive haemothorax in 5 (9.3%). Massive haemothorax means initial drainage of blood through chest tube of greater than 1500 mL or continuous drainage of greater than 250 mL per hour for three consecutive hours following insertion of thoracostomy tube. Others were four (7.4%) patients with haemorrhagic shock from gunshot wound and vascular injury.

**Figure 5** Incidence of Immediate Treatable Causes of Death



Seventeen (31.5%) of the patients had type of injury classified as immediate treatable causes of death if not identified and properly treated immediately. Massive haemothorax was the commonest type of these injuries followed by haemorrhagic shock.

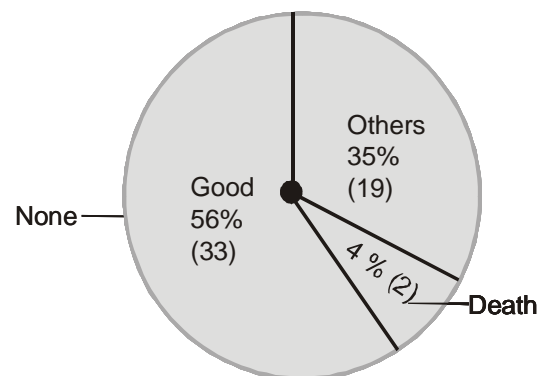
Chest radiogram was the commonest diagnostic investigation as it was used in 43 (79.6%) patients, while 10 (18.5%) had other investigations including limb radiogram, toe pulse oximetry, abdominal ultrasound scanning, and diagnostic thoracocentesis. One patient (1.9%) who had cardiac tamponade did not have any specific investigation done before he died in the emergency room.

Forty (74.1%) of the patients with cardiothoracic surgical emergencies had associated injuries in one or more other organ systems. Such injuries included head injury, spinal injury, abdominal injury, skeletal fractures, dislocation, abdominal injury, genitourinary and soft tissue lacerations. Fourteen (25.9%) of the patients were free from associated injury.

The definitive treatment offered to 28 (51.9%) of the patients was closed tube thoracostomy drainage (CTTD). Seven (13.0%) of the patients had other forms of treatment such as arrest of bleeding, wound care, antibiotic and analgesic therapy.

Nineteen (35.2%) of the patients were referred to other centres with cardiothoracic surgical service outside Akwa Ibom State. Of the thirty five (64.8%) of the patients treated here, 30 (55.6%) had good outcome defined as satisfactory functional recovery, three (5.6%) absconded before the end of treatment

**Figure 6: Overall Outcome**



Thirty (55.5%) of the patients had good outcome as judged by complete functional recovery, 19 (35.2%) were referred, 3 (5.6%) absconded and 2 (3.7%) died in hospital.

and two (3.7%) died in hospital. Nineteen patients (35.2%) were referred out for revascularization operation for limb salvage, emergency thoracotomy for treatment of massive haemothorax, and elective thoracotomy for treatment of clotted haemothorax (fig.6).

**DISCUSSION**

Cardiothoracic surgical emergencies are fairly common life-threatening surgical emergencies. This can occur as chest injury and/or extra-thoracic vascular injury involving intra-abdominal vessel(s), neck vessel(s) or peripheral vessel(s). In United States of America, chest injury is estimated to occur in 12 persons per million populations per day<sup>1</sup>. The same study pointed out that about 33% of these injuries would demand hospitalization and that chest injury contributed to about 50% of all trauma related deaths<sup>1</sup>.

This study reveals a total of 54 cardiothoracic surgical emergencies in our centre during the 12-month

period under review. This is a significant number and much higher than the nine cases noted in Ilorin by Solagberu et al<sup>2</sup>. We also noted male: female ratio of 2: 1 and predominant involvement of young adult (65%). This is an active age group that is predominantly involved in a lot of activities like motorcycle riding, vehicle driving, and traveling, touting and even crime. In our culture, men are expected to be the bread winners for their homes, and are therefore expected to engage more in those activities, and therefore more at risk of injury than women. This pattern is seen in other similar studies<sup>2,3,4,5</sup>.

This study also reveals that road traffic accident (RTA) alone was responsible for the greater proportion of cardiothoracic surgical emergencies (57.4%). RTA is also noted in another related study to be a major cause of surgical emergencies<sup>2</sup>. Assault and armed robbery attacks were the mechanisms of injury in 25.9% of cases. Various weapons were used to cause various types of injuries including blunt and penetrating chest injuries to the chest wall and intrathoracic organs. Gunshot injury and knife stab were the mechanisms of injury in all penetrating chest injury and some peripheral vascular injury. There was no case of gunshot injury to the neck involving neck vessels in this study. However this type of injury appears to be common in Enugu, Nigeria resulting in traumatic carotid-jugular fistula<sup>6</sup>. There was also no case of penetrating chest injury caused by fall from height and impalement injury, a mechanism reported by Eze and Aghaji<sup>7</sup>. In a study from Calabar analyzing gunshot injuries, cardiothoracic involvement was 16%, necessitating limb amputation in 4% of the patients<sup>3</sup>.

Rare mechanisms of injury in this study were fall from height, hit by falling object, and iatrogenic femoral vessels injury during groin dissection and another one during femoral herniorrhaphy.

Motorcyclists constituted 24.1% of the patients in this study. This was not a surprising finding because of the over-patronage of motorcycles as means of both intra- and inter-city transportation in Akwa Ibom State where this centre

caters for primarily. Commercial motorcycling provides an immediate source of income thereby luring the teeming population of un-employed youths, apprentices, traders, military men and even low salary-earning civil servants to this business popularly called "aka uke?" in the local dialect. The reckless attitude and conveyance of more than one passenger at a time by most commercial motorcyclists are the risk factors exponentially increasing their risk of RTA<sup>8</sup>. Drivers, business people and driver's assistants (conductors or motor boys) are also exposed to a high risk of motor vehicular accident; because of high level of traveling involved in these groups of occupations<sup>2</sup>. The heterogeneous group represented as others in this study consisted of pupils, students, clergies, applicants, etc.

Most (74.1%) of the patients in this study presented primarily while only 25.9% presented as referral after an initial presentation to other hospital(s). This is probably because our centre was the only tertiary health care institution in this state with 31 local government areas, as at the time of this study. No similar studies elsewhere reviewed included mode of presentation in their analysis.

The majority (64.8%) of the patients in this study were haemodynamically stable on presentation. This was also observed in a previous study by Madziga<sup>5</sup>. The remaining (35.2%) of the patients were unstable at presentation and these were the patients with haemorrhagic shock, tension pneumothorax, open pneumothorax, massive haemothorax or cardiac tamponade who needed an aggressive cascade of resuscitatory measures to live. This high level of unstable presentation compared with the four percent in the Solagberu study is thought to be as a result of the vital nature of the cardio-pulmonary organ system which was injured in the present study. The Solagberu study reviewed injuries to all organs systems in the body<sup>2</sup>.

Chest injury comprised the majority (85.2%) of injuries in this study with blunt or closed chest injury accounting for 59.3%, penetrating chest injury 20.4% and combined in 5.6%. These findings agree



with findings of other workers<sup>9,10,11</sup>. Major vascular injury which was the type of injury in the remaining 14.8% of patients consisted mainly of peripheral vascular injuries, caused by RTA, gunshot injury, stab wound and iatrogenic injury to femoral vessel during groin dissection and femoral herniorrhaphy in two patients. There was no case of injury to abdominal vessels or neck vessels caused by gunshot injury in our study. Ezemba et al in Enugu, Nigeria reported two patients with traumatic carotid - jugular fistula resulting from gunshot injury to the neck<sup>6</sup>.

This study reveals that majority (74.1%) of the injuries occurred within a distance of 35 miles (56 km) from the hospital, 18.5% between 35 and 70 miles (56-112 km), and 7.4% beyond 70 miles (112 km). These findings call for establishment of land ambulance service which is more suitable and effective for transporting casualties within distances of 35 miles than air ambulance<sup>12</sup>. However, the use of air ambulance to transport cardiothoracic surgical emergencies from site of injury to trauma centres beyond 35 miles is more effective and efficient than land ambulance<sup>12</sup>. This greatly enhances presentation at the trauma centre within the golden hour, which is consistent with prompt resuscitation, timely treatment and good outcome. Other Nigerian studies on similar subject have been silent on distance from site of injury to trauma centre. Early presentation is positively correlated with good outcome, assuming constancy of all other prognostic factors. This was also revealed by the study on paediatric blunt abdominal trauma in Zaria, Nigeria, by Ameh and Nmadu<sup>13</sup>. The delay in presentation in this study is blamed on the inherent risk in, and problems associated with taking accident victims to hospital in some parts of Nigeria. Drugs including those used for resuscitation, and other consumable items in most Nigerian hospitals are dispensed on 'cash and carry' basis. This means that any good 'Samaritan' taking accident victims to the hospital should be willing and able to pay for the treatment of the patient(s) in addition. The police investigating the cause of the injury would also regard the good

'Samaritan' as being connected to the injury thereby discouraging people from helping to take accident victims to hospital.

Haemothorax or haemo-pneumothorax was the commonest type of injury (59.3%) recorded in this study. This is probably because of the large surface areas of the parietal pleura, lungs and other intra-thoracic contents, which when injured could produce haemothorax, haemo-pneumothorax or pneumothorax. This type of injury can result from blunt or penetrating chest injury. This correlates well with the findings in Lagos, Nigeria by Thomas and Ogunleye<sup>14</sup>. Rib fracture occurred in 40.7% of the patients. Most cases of rib fractures were as a result of blunt rather than penetrating chest injury.

Major airway injury and mediastinal injury occurred in two patients (3.7%) respectively. The major airway injuries were blunt injury to cervical trachea in one patient, and machete cut into the cervical trachea in another patient who was assaulted by his neighbour. Injury to the major airway is a life threatening injury and therefore should be diagnosed early and properly treated to avert mortality<sup>15</sup>. The mediastinal injury noted in this study was one case each of haemo-pericardium and oesophageal perforation caused by blunt and penetrating injury respectively. There was no case of diaphragmatic rupture in this study. Although this injury is generally uncommon, its non-existent here may be as a result of missed-diagnosis in those who would later present as acquired diaphragmatic hernia<sup>4,16,17</sup>. Other types of injury in this study included major vascular injuries (14.8%) resulting from RTA, gunshot injury, stab wound and iatrogenic injuries during surgical operations in the groin. Two patients presented late with gangrene of leg and were treated by limb amputation. Others were referred for revascularization operation in cardiothoracic centres outside Akwa Ibom State.

The incidence of immediate treatable causes of death in this study was rather high at 31.5%. These included massive haemothorax which usually indicate

bleeding from a major vessel and not the lung parenchyma and therefore not likely to stop on conservative management of pleural drainage and volume replacement. It constitutes one of the indications for emergency thoracotomy in chest injury<sup>18</sup>. Major airway injury, flail chest and tension pneumothorax occurred in two patients each, while open pneumothorax and cardiac tamponade occurred in one patient each. The presence of any of these entities should be urgently identified, and treated to avert the high mortality that is associated with them<sup>9,11,12</sup>.

Forty-three (79.6%) of the patients had plain chest radiogram as the sole diagnostic investigatory tool, 18.5% had other investigations as ultrasound scanning, pulse oximetry, limb radiography and diagnostic thoracentesis. These investigations were grossly inadequate and cannot make precise diagnosis of chest injury<sup>19</sup>. As our centre is planning to set up a cardiothoracic surgery unit, echocardiography with both trans-thoracic and trans-oesophageal probes, computed tomographic scan (CTS), fluoroscopic screening, angiography, video-assisted thoracoscopic surgery (VATS), magnetic resonance imaging (MRI), bronchoscopy, and oesophagoscopy should be planned alongside. The role of serum level of cardiac enzymes like cardiac troponin I and creatine kinase MB isoenzyme is widely recognized and should be utilized by all centres<sup>20,21</sup>.

Extra thoracic injury was present in up to 74.1% of the patients. This was a high figure and did increase morbidity and mortality. The injuries included musculo-skeletal, abdominal, neurological, and genito-urinary injuries. This calls for an holistic approach in evaluation of all trauma patients. This same spectrum was noted by other workers<sup>5,9,10,11,22</sup>.

The specific treatment given to about 51.9% of the patients in this study was closed tube thoracostomy drainage. This means of treatment is known to be

sufficient for the treatment of up to 80-85% of patients with chest injury whereas the remaining 15% would demand a more invasive operation like thoracotomy, median sternotomy, and laparotomy<sup>11,14</sup>. The remaining patients were referred to cardiothoracic centres outside Akwa Ibom State (35.2%), treated with limb amputation (3.7%) or treated with analgesic, antibiotic and other supportive measures (9.2%).

The majority (55.5%) of the patients had good outcome determined by good functional recovery, 35.2% who were referred could not be determined, same as the 5.6% that absconded, with 3.7% mortality. The referral level was rather high but is not unexpected in a centre with no functional cardiothoracic unit like ours.

#### CONCLUSION:

This study showed the big morbidity burden associated with cardiothoracic surgical emergencies, which are fairly common in Uyo, Nigeria. Improving the transportation system in the state whereby motorcycles would be replaced with cars and buses can reduce this burden. Establishment of a well-equipped functional cardiothoracic surgery unit is urgently needed in this healthcare institution to reduce the referral, morbidity and mortality level experienced during the short period under review.

## REFERENCES

1. LoCicero J 3rd, Mattox KL: *Epidemiology of chest trauma. Surg Clin North Am* 1989 Feb; 69(1): 15-9
2. Solagberu BA, Duze AT, Kuranga SA, Adekanye AO, Ofoegbu CKP, Odelowo EOO: *Surgical Emergencies in a Nigerian University Hospital. Nigerian Postgraduate Medical J* 2003 Sept; 10 (3): 140-3
3. Udosen AM, Etiuma AU, Ugare GA, Bassey OO. *Gunshot injuries in Calabar, Nigeria: indication of increasing societal violence and police brutality. African Health Sciences* 2006; 6 (3): 15-9
4. Jamabo RS, Eke N: *Traumatic rupture of the diaphragm. Sahel Medical J* 2005; 8(1): 45-52
5. Madziga AG: *Arrow injuries in North East Nigeria. West African J M* 2003; 22 (2): 34-9
6. Ezemba N, Ekpe EE, Ezike HA, Anyanwu CH. *Traumatic Common Carotid-Jugular Fistula. Texas Heart Institute J* 2006; 33 (1): 81-3.
7. Eze JC, Aghaji MAC. *Experience with the Management of unusual Penetrating Chest Injury. Journal of College of Medicine* 2002; 7 (1): 7-11
8. Udosen AM, Ngim NE. *Commercial motorcyclists: Do they care about road safety? Nigerian Medical Practitioner* 2007; 51 (6): 23-7
9. Feliciano DV, Rozycki GS: *Advances in the diagnosis and treatment of thoracic trauma. Surg Clin North Am* 1999 Dec; 79(6): 1417-29
10. Campbell DB: *Trauma to the chest wall, lung, and major airways. Semin Thorac Cardiovasc Surg* 1992 Jul; 4(3): 234-40
11. Mandal AK, Sanusi M: *Penetrating chest wounds: 24 years experience. World J Surg* 2001 Sep; 25(9): 1145-9
12. Mattox KL, Feliciano DV, Burch J, et al: *Five thousand seven hundred sixty cardiovascular injuries in 4459 patients. Epidemiologic evolution 1958 to 1987. Ann Surg* 1989 Jun; 209(6): 698-705; discussion 706-7
13. Ameh AM, Nmadu PT. *Gastrointestinal injuries from blunt abdominal trauma in children. East African Medical Journal* 2004; 81 (4): 220-7
14. Thomas MO; Ogunleye EO. *Penetrating chest trauma in Nigeria. Asian Cardiovasc Thorac Ann.* 2005; 13(2):103-6
15. Balci AE; Eren N; Eren S; Ulkü R. *Surgical treatment of post-traumatic tracheobronchial injuries: 14-year experience. Eur J Cardiothorac Surg.* 2002; 22(6): 984-9
16. Mamman M, Raymond B, Sani A. *Traumatic Diaphragmatic Hernia: A Case Report. Highland Medical Research Journal* 2004 2 (2): 72-6
17. Nursal TZ; Ugurlu M; Kologlu M; Hamaloglu E. *Traumatic diaphragmatic hernias: a report of 26 cases. Hernia* 2001; 5(1): 25-9.
18. Karmy-Jones R; Jurkovich GJ; Nathens AB; Shatz DV; Brundage S; Wall MJ; Engelhardt S; Hoyt DB; Holcroft J; Knudson MM. *Timing of urgent thoracotomy for hemorrhage after trauma: a multicenter study. Arch Surg.* 2001; 136(5):513-8
19. Peytel E; Menegaux F; Cluzel P; Langeron O; Coriat P; Riou B. *Initial imaging assessment of severe blunt trauma. Intensive Care Med.* 2001; 27(11):1756-61
20. Adams JE; Dávila-Román VG; Bessey PQ; Blake DP; Ladenson JH; Jaffe AS. *Improved detection of cardiac contusion with cardiac troponin I. Am Heart J.* 1996; 131(2):308-12
21. Salim A; Velmahos GC; Jindal A; Chan L; Vassiliu P; Belzberg H; Asensio J; Demetriades D. *Clinically significant blunt cardiac trauma: role of serum troponin levels combined with electrocardiographic findings. J Trauma.* 2001; 50(2):237-43
22. Ceran S; Sunam GS; Aribas OK; Gormus N; Solak H. *Chest trauma in children. Eur J Cardiothorac Surg.* 2002; 21(1):57-9