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AN AUDIT OF PERIOPERATIVE CARDIAC ARREST AT LAGOS UNIVERSITY TEACHING HOSPITAL

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ABSTRACT

Objective: Intraoperative cardiac arrests are not uncommon and are related to both surgical and anaesthetic factors. This study aimed to examine the factors which predispose to a periopeartive cardiac arrest, to assess the appropriateness of therapy and the outcome.

Materials and Methods: All perioperative cardiac arrests in adults that occurred in a one year period(January 2003 to December 2003) at the Lagos University Teaching Hospital were prospectively studied. All patients less than16 years and cardiac arrests occurring outside the direct supervision of the anaesthetists were excluded. Study variables included demographic data, ASA score, urgency of surgery, surgical procedure, aetiology, time and duration of arrest, cardiac arrest rhythm, management as well as immediate outcome and survival to hospital discharge.

Results Thirteen cardiac arrests occurred in 2147 cases (incidence of 6 per 1000). The mean age of patients was 30.23 ± 11.06 years. Ten patients had an ASA score greater than 3. Hypovolaemia was responsible for arrests in 9 patients. Two arrests occurred at induction, 7 intraoperatively and 4 postoperatively. Seven patients had non-VF/VT rhythms. Cardiopulmonary resuscitation was instituted immediately. The mean duration of arrest was 25.66 ± 13.34 minutes. Drug and defibrillator therapy were inadequate. Immediate survival occurred in 5 patients (38.46%). Factors associated with significant difference in recovery from a cardiac arrest were type of surgery (p=0.043) and duration of resuscitation (p=0.022)

Conclusion: Majority of cardiac arrests were due to hypovolaemia from massive blood loss. There is a need for the provision of adequate banked blood as well as improvement in training in the management of in-hospital cardiac arrest to ensure a better outcome.

Key words: Witnessed cardiac arrest; cardiopulmonary resuscitation, outcome *(Accepted 14 August 2006)*

INTRODUCTION

Cardiac arrests during anaesthesia and surgery are related to numerous factors including physical state of patient, surgical procedure, urgency of surgery and factors related to anaesthesia[1]. With better perioperative monitoring, improved surgical techniques and better resuscitation skills, the frequency of perioperative cardiac arrest have declined over the years[2,3].

Witnessed arrests are easier to resuscitate[4] and anaesthetists in their unique position of direct monitoring of the patient armed with adequate knowledge are in the best position to diagnose a cardiac arrest and promptly institute therapy to ensure an early return of spontaneous circulation thereby limiting neurological sequelae. This study aimed to examine the incidence, aetiology and outcome of perioperative cardiac arrest and the appropriateness of therapy instituted. We also wished to determine whether survival rates differed significantly according to type, time and duration of arrest as well as numerous patient-related and surgical-related factors.

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MATERIALS AND METHODS

The study was carried out in the operating theatre complex of the Lagos University Teaching Hospital. This was a prospective study of all preoperative adult cardiac arrests that occurred in a one year period from January 2003 to December 2003. Cardiac arrest was identified as absence of central pulses, loss of consciousness and absent respiration if breathing spontaneously. Study period was from induction of anaesthesia till discharge from recovery room or 24hrs postoperatively in Intensive care unit (ICU).

Exclusion criteria included patients less than 16

years, cardiac arrests which occurred outside the direct supervision of the anaesthetists (outside theatre or ICU).

Study variables included patient age, gender, American Society of Anesthesiologists (ASA) score, surgical procedure, urgency of surgery as well as the aetiology, timing, diagnosis and duration of arrest. Cardiac arrest rhythm and management of arrest were recorded. Overall outcome was documented as successful or unsuccessful. Resuscitation was said to be successful if there was return of spontaneous circulation (ROSC) and the patient was then transferred to the ICU. Survival to hospital discharge was obtained from patients' medical records.

Statistical analysis was performed using SPSS (version 10.0) and Epinfo 2002 statistical packages. All numerical data i.e. age, dose of drugs, duration of arrest were expressed as mean ± SD. Students't-test was used to determine the effects of mean duration of arrest on survival while Chi-sq was used to analyse the effect of all other variables on survival. A p-value of < 0.05 was considered statistically significant.

RESULTS

During the study period, 2147 operations were performed. Thirteen (13) cardiac arrests occurred giving an overall incidence of 6 per 1000. Six (6) cardiac arrests occurred in 1890 elective cases (incidence of 3.2 per 1000) while 7 occurred in 657 emergency cases (incidence of 10.6 per 1000).

Six patients were male (46.2%) while 7 were female (53.8%). The age range was from 16 to 56 years with a mean age of 30.23 ± 11.06 yrs. Ten patients (76.9%) who suffered an arrest had been classified as ASA 3 or more. (Fig.1).

Fig 2 shows the surgical specialties involved. Majority of arrests occurred with major gynaecological and abdominal surgeries (69%).

Two arrests occurred at induction (15.38%), 7 intraoperatively (53.84%), while 4 occurred postoperatively (30.76%).

Hypoxaemia was thought to be the cause of the arrest in 2 patients (15.4%), hypovolaemia in 9 patients (61.5%) and increased intra-abdominal pressure from massive pneumo-peritoneum created during laparoscopy in 2 patients(15.4%) scheduled for Day Case surgery.

Pulseless electrical activity (PEA) was the commonest arrest rhythm recorded (38.5%), followed by ventricular fibrillation /Pulseless ventricular tachycardia (VF/VT) (23.1%) and Asystole (15.4%). Tree (3) patients did not have electrocardiograph (ECG) monitoring at the time of arrest (Table 1). The presiding anaesthetists diagnosed the cardiac arrest by the use of the Precordial stethoscope (PCS) in 6 patients (46.2%), End-tidal Carbondioxide ($ETCO_2$) in 3 (23.1%), clinical observation and electrocardiograph (ECG) in 1 patient each.

The mean duration of arrest of all cases was 25.7 ± 13.3mins with a range of 5 50mins.

All patients had an endo-tracheal tube (ETT) inserted if not already in place at the time of arrest and were given 100% O_2 by manual ventilation. Chest compressions were immediately commenced. Table 2 shows the drug therapy instituted. Epinephrine and atropine were given to all patients at a mean dose of 2.92 mg and 2.78 mg respectively. All patients with recorded VF/VT were defibrillated with a total of 760J given over 3 shocks.

Immediate outcome revealed return of spontaneous circulation in 5 patients (38.5%). Survival to hospital discharge occurred in 4 patients (30.8%) Fig 3. One patient who had ROSC eventually died from disseminated intravascular coagulopathy (DIC) 24 hrs later. (Fig 4).

Factors influencing survival are shown in Table 3. Survival rates were not significantly influenced by the ASA score, gender of patient, type of arrest, time of arrest, urgency of surgery or probable cause of arrest. The only factors which significantly influenced the outcome was the duration of arrest ($p=0.022$) and type of surgery ($p=0.043$). The mean duration of arrest in immediate survivors was 14.6 ± 8.26 mins (range 5 25 mins) which differed from that of non-survivors 32.8 ± 9.39 mins (range 15 50mins) ($p=0.004$).

Table 1. **Cardiac Arrest Rhythms**

Rhythm	**No.**	**%**
Ventricular Fibrillation/ Ventricular Tachycardia	3	23.1
Asystole	2	15.4
Pulseless Electrical Activity	5	38.5
Not Monitored	3	23.1
Total	**13**	**100**

Table 2. **Drug and Defibrillation therapy given during arrest**

Therapy given	***No. of patient***	***Mean dose ± SD***	***Mean number of doses***
Epinephrine	13	2.92mg ± 1.37	3.0
Atropine	13	2.78mg ± 0.79	1.5
Defibrillation	3	760J	3

Table 3 **Factors determining immediate survival**

	Group (No)	Immediate Survivors *No (%)*	P value
Urgency	Elective (n=6)	2 (33.3%)	1.00
	Emergency (n=7)	3(42.8%)	
ASA score	1&2 (n=3)	2(66.7%)	
	3&>(n=10)	3(30.0%)	
0.510			
Time of arrest	Induction(n=2)	1(50.0%)	
	Intra-op(n=7)	3(42.8%)	
	Post-op(n=4)	1(25.0%)	0.783
Gender	Male(n=6)	3(50.0%)	
	Female(n=7)	2(28.6%)	0.592
Surgery	Abdominal (n=4)	3(75.0%)	
	Gynae major(n=5)	0(0%)	
	Gynae lap (n=2)	2(100%)	
	Thoracic (n=1)	0(0%)	
	Maxillo (n=1)	0()%)	
0.043			
Cause	Hypovol(n=9)	3(33.3%)	
	Hypoxaemia(n=2)	0(%)	
	Inc IAP (n=2)	2(100%)	
0.102			
Rhythm	PEA/Asystole (n=7)	2(28.6%)	0.475
	VF/VT (n=3)	0(0%)	
Duration of Arrest	<20mins (n=5)	4(80.0%)	0.022
	20 mins &>(n=9)	1(11.1%)	

Fig 1 ASA Classification of patients

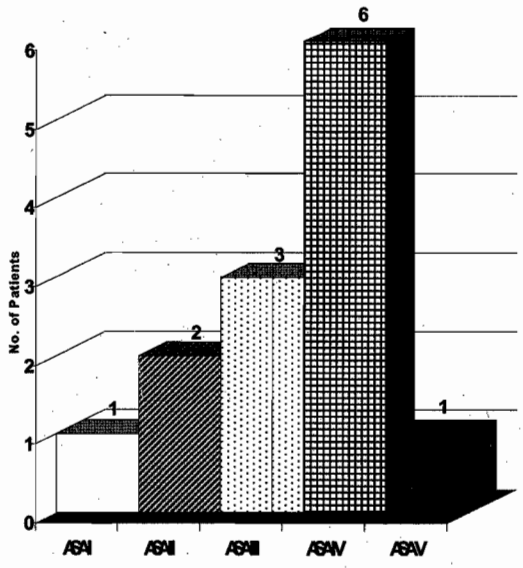


Fig 2. **Surgical Specialties of patient population**

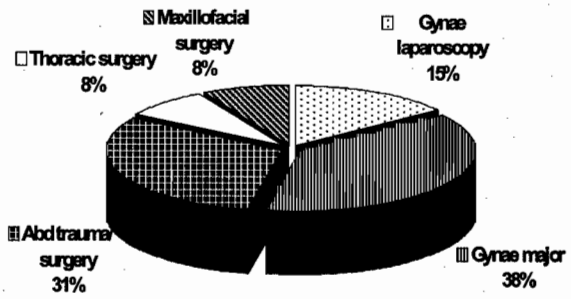
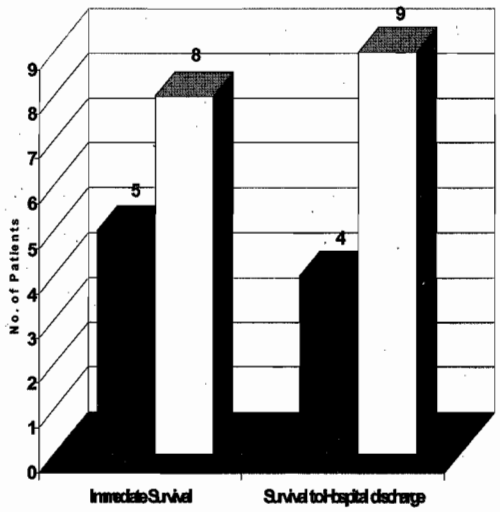


Fig 3. Outcome of Patients



Legend to Figure 3

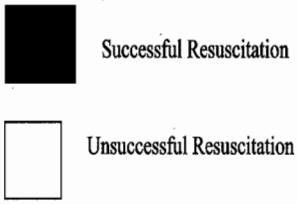
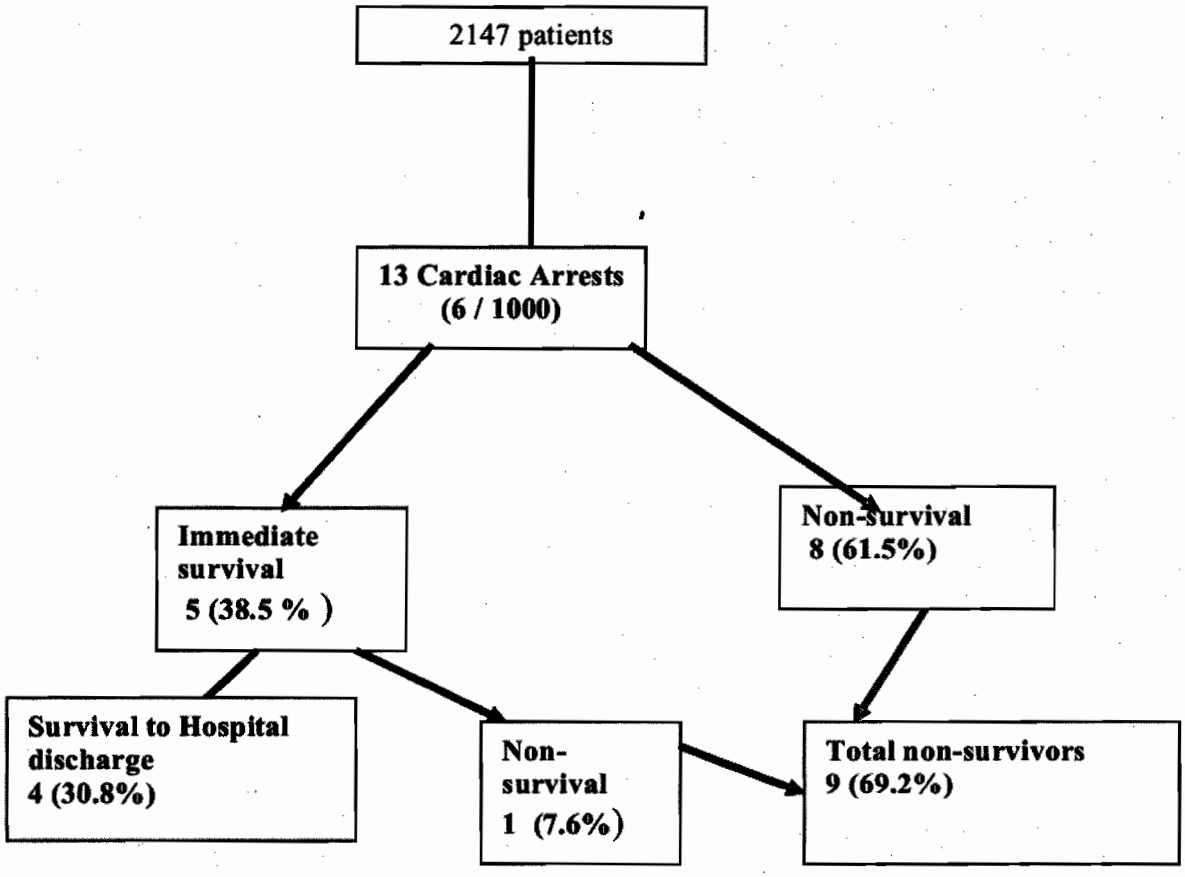


Fig 4. **Survival of CPR attempts**



DISCUSSION

The overall incidence of cardiac arrest in our study (6/1,000) were similar to figures obtained by Sanusi et al[5] in Ibadan but far exceeded those from more developed countries which ranged from 1.1 19.7/10,000.[1,2,6]. This may be a reflection of a health care system with poor referral resulting in late presentation to tertiary centres, inadequate supply of banked blood and inadequate resuscitation skills worsened by the lack of automated patient monitoring in the operating room, recovery room, ICU and emergency room.

Several factors have been implicated in the aetiology of perioperative cardiac arrest and these are both anaesthetic and surgically related. A Study Commission in Nebraska classified the primary cause of perioperative cardiac arrests as anaesthesia-attributable, anaesthesia-contributory, surgical-related, related to patient disease or unable to decide[1].

Emergency surgery is a known risk factor for cardiac arrest[2,5,7]. Sprung[2] in his study identified, that 98% of his patient population who had cardiac arrests were having emergency procedures done. Keenan and Boyan[8] observed that the risk with emergency surgery was 6 times that of elective procedures.

We obtained a three-fold increase in incidence of arrest in our emergency population. This could be due to inadequate knowledge of patient's premorbid organ function, inadequate preparation, especially in bleeding emergencies, less experienced anaesthetic and surgical coverage for emergency procedures and inadequate supply of banked blood and blood substitutes.

The ASA classification assesses the patients' physical status. The higher the ASA score, the more the organ dysfunction related to disease. Studies have shown increased mortality in patients classified as ASA 3 or higher[2,6,9,10]. Ten of our patients (76.9 %) were classified as ASA =3 and therefore at high risk. Standard intra-operative monitoring should be available during the entire course of any anaesthetic. This is essential to 'warn' of any untoward event and allow prompt management. Sanusi[5] emphasized that the paucity of monitoring could contribute to delayed detection and therefore initiation of treatment for cardiac arrest.

The Precordial stethoscope which provides a means of monitoring heart and breath sounds diagnosed cardiac arrest in majority of our cases (46.2%). Though this equipment is rarely used in developed

countries except perhaps in paediatric anaesthesia, it is a valued tool in this sub-region as it is readily available and inexpensive. It however does not warn of impending arrest as the intensity of the heart sounds does not correlate to cardiac output in adults. Nevertheless diagnosis of bradycardia and arrhythmias can be made before an arrest ensues. Capnography measures the expired CO_2 content and a sudden drop can indicate cardiac arrest, massive pulmonary embolism or disconnection. Though a precipitous fall in $ETCO_2$ occurred to levels approx 1KPa, only 3 anaesthetists identified this as being due to an arrest. Likely reasons include inadequate knowledge regarding the parameters monitored by this equipment or searching for other causes of this drop in value. Ten patients had ECG monitors attached, despite this, the attending anaesthetists diagnosed cardiac arrest via the ECG in only one case. Persistent problems with leads and electrodes or inability to correctly read the ECG strip may have contributed to the anaesthetist ignoring the rhythm pattern on the screen.

Surgical procedure influences the occurrence and outcome of cardiac arrest. In assessing deaths attributable to anaesthesia in New South Wales, Warden[11] observed that ¾ of cardiac arrests occurred in abdominal, cardiothoracic and vascular surgery. Major surgical procedures associated with massive bleeding are well known risk factors for cardiac arrest[2,5,7,12] .Sprung[2] suggested that patients who experienced arrest due to bleeding were more likely not to survive to hospital discharge and that the presence of hypotension prior to arrest was a significant predictor of mortality. Hypovolaemia from massive blood loss worsened by inadequate supply of banked blood resulted in cardiac arrest in 9 of our patients (61.5%) who were having major gynaecological, abdominal, thoracic and maxillofacial surgeries. Only three of these patients survived. Two patients had arrests at induction due to haemorrhage from abdominal gun shot injury and ruptured ectopic pregnancy. Increased intra-abdominal pressure as a result of massive pneumo-peritoneum was the cause of arrest in 2 fit patients (15.4%) scheduled for Day Case laparoscopy. Increased intra-abdominal pressure may result in extreme vagal stimulation, impediment to venous return resulting in a drop in cardiac output or CO_2 embolisation which may culminate in cardiac arrest[13].

Anaesthesia-attributable factors which include mainly hypoaxemia due to airway management difficulties, drug overdose, vagal reaction and histamine release[1,6] were not observed in this study. No cardiac arrest occurred as a result of airway management difficulties.

This reflects Good airway management skills amongst presiding anaesthetist comprising thorough preoperative airway assessment, correct choice of anaesthetic technique and early realization of a difficult airway scenario. Anesthesia -contributory factors include inadequate preoperative preparation, inadequate postoperative care or inappropriate anaesthetic technique[11]. From our study, anaesthesia-contributory factors could include inexperience in interpretation of displays obtained on capnography and ECG resulting in a delay in diagnosis.

Pulseless electrical activity (PEA) was the commonest rhythm identified which is not unexpected as majority of the patients were hypovolaemic. This was managed with chest compressions and the administration of epinephrine and atropine. VF/VT are common in patients with organic heart disease but may also occur with increased circulating catecholamines, sympathetic imbalance, metabolic abnormalities, electrolyte imbalance, shock and hypo/ hyperthermia[14]. Effective defibrillation is the single most important therapy for VF/VT[14,15]. It produces higher immediate survival scores compared with non-VF/VT rhythms[15]. All our patients with VF/VT were defibrillated but none survived as defibrillation therapy given were grossly inadequate.

We were able to achieve ROSC in more than 1 in 3 of our patients .Immediate survival occurred in 38.5% and survival to hospital discharge in 30.8% of our patients which is a vast improvement from results of 19% obtained by Ene and Sodipo[9] in this same institution in 1975. This reflects the improvement in monitoring skills and anaesthetic techniques that have occurred over the decades. Our immediate outcome indices were similar to those obtainable from other parts of the world[2,4]. Survival to hospital discharge further diminished as post-arrest patients may suffer from numerous life-threatening arrhythmias, various organ failures and secondary brain injury which further increase mortality[16]. We were unable to flow-up our survivors to obtain long-term outcome i.e. survival to 6 and 9 months and level of disability if any.Factors responsible for survival after cardiac arrest in our study were duration of arrest and surgery performed.Cardiopulmonary resuscitation (CPR) which lasted more than 20 minutes before success was significantly less likely to be successful. It has been emphasized that resuscitation time reflects the severity of ischaemic injuries before and during CPR[15]. One study observed that duration of arrest > 15 minutes was a significant predictor of mortality[17]. One researcher observed that patients who experienced an arrest during an elective procedure were more likely to survive than those undergoing an emergency procedure[2]. We however

found in our study that though Patients having emergency surgery were more likely to have an arrest, their survival was not significantly different from those having elective procedures. We found no significant difference in the influence of ASA score, timing of arrest, gender, arrest rhythm or probable cause of arrest on the ROSC in this study

CONCLUSION

Perioperative cardiac arrest is still relatively common in our environment. Our study points out the need for improvement in knowledge and skill especially in drug and defibrillation therapy. Hospital changes that must occur include the availability of banked blood to improve survival in emergency cases as we have shown that most cardiac arrests are related to massive blood loss. More should be done to follow-up survivors to determine the level of disability and therefore the severity of global ischaemia suffered during the circulatory standstill.

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