ANESTHETIC DEATHS IN A DEVELOPING COUNTRY*

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Summary

It is important to ascertain the contribution of anesthesia to perioperative mortality in order to enable improvement in the safety and quality of care. Scanty literature regarding anesthetic mortality from developing countries is available. We present data regarding anesthesia related mortality in a university hospital in a developing country.

We reviewed all patient deaths occurring between 1992-2003 occurring within 24 hours of anesthesia, as part of departmental quality assurance activity. The aim of study was to identify any contributing factors associated with mortality, and to compare our data with similar studies from developed and developing countries.

111, 289 cases were handled in this period. Within 24 hours the crude mortality was 35 (3.14: 10,000). 3 patients died at induction, 13 intraoperatively and one at emergence. In the postoperative period 18 (51%) cases of mortality occurred. In 4 (11%) cases anesthesia was found to be solely responsible (0.35 per 10,000), in 8 (23%) cases anesthesia was found to be partially responsible (0.7 per 10,000). In 23 patient disease and surgical factors played a primary role. In 10 (28.5%) cases deaths were considered to be avoidable.

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Two time periods were also compared. Between 1992-1998 anesthesia mortality was 0.68: 10,000 anesthetics, and from 1999-2003 it was 0.18: 10,000 Higher mortality was observed with advancing age, higher ASA status, emergency and complex surgical procedures. Human factor, human error, inadequate preoperative preparation, inappropriate postoperative care and lack of supervision were identified as preventable factors.

Key words: Anesthetic, Mortality, Complications.

Introduction

The risk of death associated with surgery and anesthesia has been studied extensively. Recent studies define mortality associated with anesthesia as death under, as a result of, or with in 24 hours of an anesthetic[1,2]. It has been suggested that anesthesia related mortality has decreased in the last three decades and currently ranges between 0.05 to 10 per 10,000 anesthetics[1,3,4]. In current literature anesthetic mortality contributes to less than 10% of the overall operative mortality[2,5].

Inspite of this decrease, insight into the contribution of anesthesia to perioperative mortality is important in order to bring about further improvements in the safety and quality of perioperative care. Evaluation of perioperative mortality provides knowledge of the quality of anesthetic management, allowing preventive measures to be instituted and also providing directions for further research.

Data related to hospital or anesthesia related mortality has not been published in our country. As part of our Departmental quality improvement program, we reviewed all the morbidity and mortality forms of patients where death was associated with anesthesia. These cases had been discussed at our Departmental morbidity and mortality meetings over the last twelve years (1992-2003).

Our objective was to look at any trends emerging over the years and to identify aspects of anesthetic management and contributing factors that

needed further improvement. We also wanted to compare our data with other studies from developed and developing countries.

Material and Methods

Aga Khan University Hospital is a 500 bed teaching hospital which caters to patient population in the southern part of the country. The Anaesthesia Department has twenty five full time faculty and thirty residents. The current annual work is approximately 9000 anesthetics, catering to all subspecialties including cardiothoracic, pediatrics, orthopedics, general surgery, neurosurgery, ENT, urology, obstetrics and gynecology, plastics and vascular surgery.

There are eight operating rooms for different specialties and two rooms are dedicated for cardiothoracic surgery. Anesthesia service is also provided to two additional operating rooms in day surgery unit and one in the obstetrics unit. All operating rooms are equipped with The American Society of Anesthesia (ASA) recommended standards of monitoring and standardized equipment. A ten bedded post anesthesia care unit (PACU) and a ten bedded general intensive care unit (ICU) are administratively under control of Anaesthesia Department. Anesthesia service is also provided to Radiology Department and for electroconvulsive therapy. A preoperative evaluation clinic was established in 1996 and runs five days a week. A twenty four hours epidural service is also provided.

All surgical patients who die within 24 hours of receiving anesthesia are routinely reported to the Departmental morbidity and mortality co-ordinator and then logged in a Departmental file. A descriptive form regarding patient's demographic information, preoperative condition, ASA status, experience of anesthetist involved, type of surgery, duration of anesthesia and surgery, time of mortality on a twenty four hour clock and sequence of events, is filled by the primary consultant anesthetist. This form has been in use since 1992.

All these cases are also presented in a monthly scheduled morbidity and mortality Departmental meeting. The cardiac anesthesia morbidity

and mortality is discussed in a separate meeting. At the time of Departmental presentation the cases are reviewed by two independent consultants not involved in the management of the patient's care. These consultants give their written opinion as regards the possible cause of death, role of anesthesia in mortality and whether the mortality was avoidable. The role of anesthesia is further classified as solely, partially or not contributing to the mortality. Suggestions are also given for improvements. A copy of the filled review form is provided to the primary consultant and the resident involved in the case for feedback purpose. Issues that are identified for improvement are further discussed at other fora related to quality improvement within the Department.

In this audit we have reviewed all the forms of patients who were anesthetized and died within 24 hours between January 1, 1992 and December 31, 2003. Cardiothoracic surgery was excluded. We also calculated and compared the data between two periods, 1992-1998 and 1999 to 2003 because of introduction of certain changes in the Anaesthesia Department work pattern.

Results

The total surgical workload handled by the Department of Anaesthesia between 1992 and 2003 comprised of 111,289 cases. The number of patients who died within 24 hours of receiving an anesthetic was 35. This gives a crude mortality rate of 0.03% (3.14 per 10,000 anesthetics). In 4 (0.35: 10,000) deaths, anesthesia was found to be solely responsible, and these were labeled as anesthesia related mortality. In 8 (0.7: 10,000) cases, anesthesia was found contributing to the mortality. In 23 cases, anesthetic management did not appear to significantly contribute to the mortality. In 15 patients, deaths were considered to be inevitable in which anesthesia and surgical techniques were apparently satisfactory. In 8 patients, comorbid and surgical factors played an important role in mortality. Male to female ratio, age and ASA status of the patients who died within 24 hours of surgery is shown in Table I. Forty percent cases who died were operated as an emergency.

Table 1
Demographic data Age, Gender and ASA status of patients who died within twenty four hours of anesthesia

Age (yrs) Mean (range)	Gender distribution	ASA Status (%)					
	Male: Female	I	II	III	IV	V	E
43 (14 days-85 yrs)	20: 15	0	5 (14)	12 (34)	15 (43)	03 (9)	14 (40)

Type of operation and surgical specialty involved are shown in Table 2. The cases belonged to a range of surgical specialties. The highest number of cases were from general surgery (n = 10).

Table 2
Type of operation and surgical specialty in which death occurred.

Type of operation	Surgical Specialty	Number
Biopsy of mediastinal mass	Thoracic	1
Blalock shunt	Thoracic	1
Thoracotomy	Thoracic	1
Thoracic spine surgery	Neurosurgery	1
Craniotomy	Neurosurgery	5
Insertion of VP shunt	Neurosurgery	1
Appendectomy	General Surgery	1
Exploratory laparotomy	General Surgery	6
Open cholecystectomy	General Surgery	1
Gastrectomy	General Surgery	1
Wound debridement	General Surgery	1
TURP	Urology	2
Nephrolithotomy	Urology	1
Laparotomy	Gynecology	3
Total abdominal hysterectomy	Gynecology	1
Tracheostomy	ENT	1
Application of external fixator	Orthopedic	1
Open reduction fracture neck of femur	Orthopedic	1
Cleft palate repair	Plastic surgery	1
Manipulation under anesthesia both knee	Orthopedic	1
Dynamic hip screw	Orthopedic	1
Abdominal aortic aneurysm repair	Vascular	1
Formation of colostomy	Pediatric	1

Primary cause of death and time of events is shown in Table 3. In majority of cases, 18 (51%), mortality occurred in the postoperative period and one at emergence. 3 patients (9%) died at induction and 13 (37%) intraoperatively.

Table 3

Cause of death and period of mortality

Period of Mortality	Case #	Primary cause of death
Induction	1.	Inability to ventilate
	2.	Inability to intubate and ventilate in a paralyzed patient
	3.	Hypokalemia
Intraoperative	4.	Cardiac arrest at the time of Blalock Taussing operation
	5.	Suspected pulmonary embolism
	6.	Cardiac arrest due to autonomic neuropathy
	7.	Hyperkalemia
	8.	Severe sepsis
	9.	Displaced tracheostomy tube.
	10.	Massive hemorrhage
	11.	Suspected pulmonary embolism
	12.	Massive hemorrhage
	13.	Massive hemorrhage
	14.	Massive hemorrhage
	15.	Sepsis/ARDS/Congenital AV defect
	16.	Pulmonary embolism
At Emergence	17.	Pulmonary embolism
Postoperative in recovery room	18.	Severe bronchospasm
	19.	Residual anesthetic effect
Postoperative in ICU	20.	Blocked endotracheal tube
	21.	Massive hemorrhage due to fungal lung infection
	22.	Omental wall infarction
	23.	Metabolic acidosis
	24.	Electro mechanical dissociation at induction
Postoperatively in ward	25.	Septic shock with DIC
	26.	Raised intracranial pressure due to cerebral secondaries
	27.	Myocardial infarction
	28.	Massive hemorrhage
	29.	Intraoperative damage to respiratory center
	30.	Severe sepsis
	31.	Sepsis and renal failure
	32.	Massive hemorrhage
	33.	Massive hemorrhage
	34.	Massive hemorrhage
	35.	Massive hemorrhage

The details of the four patients labeled as anesthesia related mortality are as follows:

The first case an ASA III elective case for craniotomy in which anesthetist was unable to intubate and ventilate the paralyzed patient at the time of induction due to an unexpected finding of a fungating tumor arising from glottis. A preoperative assessment had been conducted but the patient had not given any history or sign of upper airway problems.

The second case was an ASA IV, emergency for exploratory laparotomy who had cardiac arrest at induction. This was probably due to uncorrected preoperative hypovolemia.

The third was an ASA IV patient for emergency exploratory laparotomy who had cardiac arrest at induction due to uncorrected preoperative hyperkalemia (6 meq/l).

The fourth case was an ASA II patient for elective laparoscopic cholecystectomy who had cardiac arrest postoperatively in the recovery room due to uncorrected metabolic acidosis and residual anesthetic effect.

In eight cases anesthesia was found to be partially responsible for mortality. The anesthetic factors identified by the reviewers were drug effect and inadequate preoperative preparation. In 23 (65.7%) patients, patient's medical condition and surgical factors rather than anesthetic management played more important role in mortality.

Ten (29%) of the deaths were considered avoidable by the reviewers. Personal factors were responsible in 3 deaths which were identified as human error, inappropriate decision making related to admission of patient to the high dependency unit and inappropriate dose of narcotic given. In 4 patients the factors contributing towards death were identified as lack of experience and in 3 as error of judgment.

Inadequate preoperative preparation, inadequate postoperative monitoring, inappropriate choice of anesthetic drugs and inadequate preoperative arrangement of blood products were considered to be the avoidable factors in these cases.

In 7 (20%) deaths the problem related to the cardiovascular system and in another 7 (20%) the respiratory system was primarily involved.

Ten patients had intraoperative cardiac arrest and two had postoperative. Human error was thought to be responsible for one third of the deaths.

Comparison of the anesthetic related mortality between 1992-1998 and 1999-2003, revealed that the anesthesia related mortality was 0.68 per 10,000 anesthetics in the former period and to 0.18 per 10,000 anesthetics in the later.

Discussion

Reporting and analyzing mortalities related to anesthesia is important to identify avoidable causes, to review trends and to formulate strategies for prevention. One of the major problems in reporting data on this issue, is the lack of uniformity in operational and outcome definitions in the reported literature. Study populations differ historically and regionally with respect to perioperative risks, which makes it difficult to detect trends[6]. Nevertheless until such standardization and agreement occurs, we need to report, analyze and share data worldwide.

The first extensive study of anesthesia related mortality was by Beecher and Todd in 1954[7]. Several studies from the developed countries have reported on perioperative mortality, but few are directly comparable[3,8] There is hardly any data reported from developing countries.

In our audit, crude mortality that is combined surgical and anesthetic mortality associated with anesthesia within 24 hours was 35 (3.14 per 10,000). In literature estimates of crude anesthetic mortality ranges between 10-30 per 10,000, and anesthesia related mortality as 1.9-7.0 per 10,000 anesthetics[8-10]. Figures relating to anesthetic mortality reported from Australia between 1985 to 1999 are 0.3 to 0.13 per 10,000[2,11]. The rate of death associated with anesthesia varies from 1: 1500 in studies done in fifties and sixties[8] to about 1: 150,000 in late eighties[9].

In our study pure anesthesia related mortality was estimated to be four which translates to 0.359 deaths per 10,000, about one tenth of the crude anesthetic mortality.

The reasons for higher mortality rate in our audit as compared to developed countries may be due to the fact that we do not have an effective primary and secondary health care systems in our country, resulting in tertiary care hospitals like ours dealing with more poorly optimized sicker patients. We found thrice the anesthesia related mortality despite using standard equipments and implementation of internationally recommended anesthetic standards.

Postmortem is not a norm in our country because of cultural factors and the exact reasons for death in our cases could not be determined. It has also to be realized that our data may not reflect trends from other parts of the country, as we have better staffing, equipment and training facilities in comparison to most other hospitals.

Anesthesia related mortality figures may well be different in the developing countries where only limited trained work force, monitoring and training facilities are available. Scanty literature is available on the topic. McKenzie[14] in 1996 showed that mortality associated with anesthesia in a Zimbabwean teaching hospital was 2.58 per 1000 operations. The factors identified for such a high mortality rate were uncontrollable hemorrhage, poor preoperative and postoperative management. Harrison[10] presented an analysis of deaths attributable to anesthesia over a thirty year period (1956-1987) from Cape Town, and showed a six fold decrease from 0.43 to 0.07 per 1000 anesthetics. It was postulated that this change was due to intellectual response to information derived for ever improving vital function monitoring. Lack of qualified personnel, lack of supervision, lack of critical care facilities and lack of equipment, were the common and frequent problems reported from developing countries.

Independent predictors of operative mortality cited in literature include, advanced age, male gender, higher ASA physical status, major surgery, emergency procedure, intraoperative complication and the number of anesthesia drugs administered[15,16].

We found that inadequate preoperative preparation could have contributed to 12% of our anesthetic mortality. Different studies from developed countries quotes this figure to be 40-45%[2,17,18]. This is an

aspect of perioperative management that relates to both the anesthetist and the primary surgical specialist. Better communication and cooperation between the two can help in improving patient outcome.

The ASA physical status correlates well with overall surgical mortality[19]. Vacanti's[20] showed that there was a clear trend of increasing mortality within the first 48 hours following a procedure with increasing ASA grades. Our results correlate with Vacanti's. 30 patients (86%) who expired within 24 hours were ASA grade III or more. Only 3% of patients of anesthesia related deaths were labeled ASA II. Eichhorn[4] showed that anesthesia related mortality in ASA I and II patients was 1: 200,200 cases which were performed between 1976-1988 in Harvard Medical School Hospital. After implementation of strict monitoring guidelines there were no preventable deaths in this group of patients in the next 319,000 anesthetics. In our data this incidence is 1.8: 200,000. We are now using anesthetic mortality in ASA II and III patients as a quality indicator. The preventive recommendations that followed the results of Harvard study pertained to human (attitude, knowledge, education), and organizational system related factors (supervision, facilities).

Cardiovascular management and monitoring plays an important role in incidents with serious outcome than in incidents without residual impairment. Studies relating to anesthetic deaths report failure of control of circulatory homeostasis to contribute in 35-72% of cases[1,7]. We found that problems relating to the cardiovascular system played a role in seven (20%) anesthesia related deaths. In 6 (17%) of these cases a cardiovascular problem already existed preoperatively and persisted in subsequent phases.

Several authors are now also using intraoperative cardiac arrest as an anesthesia outcome measure. The incidence of reported intraoperative cardiac arrest in literature varies between 0.04 per 10,000[21] to 10.0 per 10,000[22]. Cardiac arrest occurring postoperatively in the recovery room varies from 0.08 per 10,000 to 7.1 per 10,000[23]. In recent studies respiratory management has contributed to approximately one quarter of the anesthesia related deaths[1,2,4]. In critical incident studies, critical incident related to respiratory problem occurred in 17-34% of

incidents[25,26]. Ten of our patients in which respiratory system was involved had intraoperative cardiac arrest (incidence 0.89 per 10,000 anesthetics) and 2 (5.71%) had postoperative cardiac arrest. In four cases, airway management was primarily involved. Severe fungal pulmonary infection, pulmonary embolism, severe bronchospasm development of ARDS and damage to the respiratory centre subsequent to neurosurgery occurred in eight cases.

In our study 43% of deaths were inevitable in which anesthesia and surgical techniques were apparently satisfactory as assessed by the reviewers. Two deaths were fortuitous due to pulmonary embolism. In one third of patients human factor contributed to the crude anesthetic mortality, which included error of judgment, human error and lack of supervision, was judged to be the contributing factors.

System related factors did not seem to play an important role in our audit results. Unfortunately definitions of human or system related factor is not yet standardized. It has been suggested that the overall contribution of human factor may be much smaller than often cited and the contribution of system related factors higher[27,28]. Further research need to be directed towards identification of such factors since elimination of system error may be more important in improving quality of care than elimination of human errors.

Overall we observed that advancing age, higher ASA status, emergency procedures, and complexity of surgical procedures, had major contributions to mortality. Preventable factors like uncontrolled hemorrhage, inadequate preoperative patient preparation, inadequate postoperative care, lack of supervision and lack of communication between surgeons and anesthetists, were identified in our audit.

Efforts to enhance safety in anesthesia should include adherence to safety standards, and use of equipments that offers modern safety features, structured system to analyze problems and to institute remedies to prevent their recurrence.

When comparing the two periods under review we observed that in the period between 1992-1998, crude mortality was 4.3: 10,000 and anesthesia related mortality was 0.68: 10,000. The crude mortality

between 1999-2003 was 1.8: 10,000 and anesthesia related mortality was 0.18: 10,000. The marked reduction in anesthetic mortality and anesthesia related mortality in last five years is comparable with the results of other developed countries[2,11]. During the last 5 year period, we started preoperative evaluation clinic to improve the preoperative patient care, strict implementation of ASA monitoring standards and improved supervision by ensuring the availability of qualified and trained staff. We also upgraded the post anesthesia care unit and more beds for high dependency for postoperative patient care were commissioned. Kawashima et-al[29] showed that in 1999 mortality rate attributable to anesthesia in Japan was 0.13 per 10,000 which was significantly reduced from 0.21 in 1994-1998.

In conclusion human factor, human error, inadequate preoperative preparation, inappropriate postoperative care and lack of supervision were identified as preventable factors in our audit. However, crude mortality and anesthesia related mortality was markedly reduced over the last five years in our institution due to certain measures introduced in anesthetic practice. We suggest the development of standardized methods of data collection and analysis in order to share data at international forums.

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