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CRITICAL INCIDENTS IN ORTHOPAEDIC ANAESTHESIA IN A TERTIARY HOSPITAL: A PROSPECTIVE AND RETROSPECTIVE STUDY

Anaesthesiology

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ABSTRACT

Background: Critical incident reporting is accepted as an effective tool to enhance anaesthesia safety. It also helps to overcome or prevent human errors and system failures. The present study was undertaken to record anaesthesia related critical incidents in patients undergoing elective orthopaedic surgical procedures and identify the incidence and potential risk factors leading to critical incidents during anaesthesia. **Method:** This prospective and retrospective observational study was conducted in patients of both sexes, above 18 years of age, who met with critical incidents while undergoing any kind of elective surgeries under anaesthesia in orthopaedic operation theatres of a tertiary care teaching hospital during a period of 2 years from June 2018 to May 2020. **Results:** During the study period, anaesthesia was given to a total of 4677 patients out of which 152 (3.25%) patients met with 310 critical incidents. Out of 310 critical incidents, 57.98% was attributable to anaesthesia, 1.94% was equipment related, 13.55% surgery related, 0.65% patient related and 25.88% was recovery related. However, cardiovascular (17.42%), airway (6.45%) and respiratory (3.87%) related critical incident were the most common. Most of the patients recovered fully (94.7%) and most of the events were preventable (96.05%). **Conclusion:** Critical incident reporting system can be established based on the data obtained and it should be there in all departments and continued training for such events can reduce severity and frequency of these occurrences. Anaesthesia related critical incidents should be continued to be reported and analysed to reduce risks and improve patient safety.

KEYWORDS

Critical incident; Anaesthesia; Orthopaedic; Cardiovascular; Respiratory

INTRODUCTION

Critical incidents associated with anaesthesia can affect the outcome of the patient. They might cause morbidity, transient damage, might prolong the duration of stay in hospital and in worst cases death. One of the most important factors while administering anaesthesia is patient safety. Critical incident is defined as "An event under anaesthesia care which had the potential to lead to an undesirable outcome if left to progress" as per Good Practice by The Royal College of Anaesthetists & The Association of Anaesthetists of Great Britain and Ireland [1]. Critical incident reporting as a technique was first used by Flanagan in the 1940s for safety and work performance of military pilots [2]. It has been widely accepted that critical incident reporting is an effective method in order to improve patient safety in perioperative anaesthetic practice. Many countries have adopted a National Reporting system for the identification of critical incidents, for example, United Kingdom (UK) National Reporting and Learning Systems (NRLS), Australian Incident Monitoring System (AIMS). However, in India, we do not have established reporting systems. Many previous studies of critical incident reporting mostly depended on record analysis. It was noted that in these studies, data were inadequate due to lack of reporting and misclassification [3,4].

However, it is a challenge to provide anaesthesia to patients about to undergo an orthopaedic procedure. The various challenges include positioning, elderly patients, prolonged operative time, major blood loss, the vital structures in vicinity of operative field, obese patients, and maintenance of hemodynamic stability [4]. One of the common contributors to morbidity and mortality in anaesthesia are the human errors. Critical incident is most of the times a preventable mishap and its reporting will help in learning and preventing the recurrences of critical incidences associated with anaesthesia due to human errors and system failures and enhance patient safety. Reporting the critical incidents in our teaching tertiary care hospital was helpful in teaching and formulate policies which will be helpful in improving quality of anaesthesia.

MATERIALS AND METHODS

This prospective and retrospective observational study was conducted in the orthopaedic operation theatres of a tertiary care teaching hospital during a period of 2 years from June 2018 to May 2020. Patients of both sexes, above 18 years of age, who met with critical incidents while undergoing any kind of elective surgeries under anaesthesia in orthopaedic operation theatres of a tertiary care teaching hospital were included in the study. Patients who did not give consent were excluded.

Retrospective study: This study group consisted of all the cases having a critical incident starting from June 2018 till the day of ethics committee approval. The details of critical incidents were collected from the records kept by the anaesthesia department for the orthopaedic operation theatre. Since it was a retrospective observational study, no consent was to be taken from this study group. It was then analysed by a senior anaesthesiologist and documentation done in the case record form provided to them. All the details of the patient and consultant associated with the surgery were kept confidential.

Prospective study: This study group consisted of all cases having a critical incident starting from period from the day of Ethical committee approval till the end of the study period. An Informed Consent was taken from the patients who underwent a critical incident in the orthopaedic theatre after the surgery, and if they were not in a situation to give consent or critical incident is of a serious nature, then consent from LAR was taken. The anaesthesia team reported and analysed the critical incidence in the format of case record form given to them. The data collected was kept confidential, as also the details of the consultant. The critical incidents reporting was kept voluntary and only reported incidents were included in the study.

Documentation for both retrospective and prospective study groups were divided into mainly: 1) Descriptive part and 2) Specific areas

1) Descriptive part:

It included general instruction to reporter like details of patients, anaesthetic technique, place of incident and time of incident.

2) Specific areas:

A) Anaesthesia related critical incident: airways, respiration, cardiovascular, neurological, metabolic, medication, equipment, positioning, physical hazards, miscellaneous and regional; B) Surgeon Related: Haemorrhage-class 1(up to 750 ml), class 2(750-1500), class 3(1500-2000), class 4(2000 or more), malfunctioning surgical instruments, wrong site operation, surgeon pulled patient without informing to anaesthetists; C) Patient Related: Inadequate starvation, non-compliance about premedication, hiding important past history, allergies not reported and D) Recovery Related: Delayed recovery, post operative ventilator requirement, ICU requirement.

Outcome included no eventuality, temporary abnormality not noticed by patient, temporary abnormality with full recovery, possibly permanent but not incapacitating, possibly permanent but incapacitating and death. Preventability included likely to be preventable with existing resources; likely to be prevented with extra resources and cannot be prevented with any resources.

Statistical analysis

The data were analysed using SPSS version 25.0 to get the number and

percentage of each critical incident. Incidence of critical incidents = the ratio of total number of critical incidents relevant to anaesthesia occurring during surgery within a specified time period to the total number of anaesthesia administered to patients for surgeries in orthopaedic OT.

Observation and Results

During the study period, anaesthesia was given to total of 4677 patients out of which 152 (3.25%) patients met with 310 critical incidents. The critical incidents were common amongst 21-30 years (21.1%) age group. The mean age of study subjects was 48.31±17.90 years with female (59.9%) predominance. These incidents were higher in ASA I 74(48.7%) and ASA II 67(44.1%). Place of incidents were higher in operation theatre 135 (88.8%). Time of critical incident was higher intraoperative period 72(47.4%). Amongst 152, 146 patients who received anaesthesia met with critical incidents, out of which 42.8% (65) were given general anaesthesia. Among the airway related incidents 6.45% (20) out of 310, the most common one was difficult intubation (2.58%) as shown in table 1.

Table 1: Demographic data of study population and factors leading to critical incidents

Parameters			Frequency	Percent
Age groups (years)	18-20		06	3.9
	21-30		32	21.1
	31-40		16	10.5
	41-50		29	19.1
	51-60		27	17.8
	61-70		29	19.1
	71-80		09	5.9
	81-90		03	2.0
	91-100		01	0.7
Gender	Male		61	40.1
	Female		91	59.9
ASA Status of the patient	ASA I		74	48.7
	ASA II		67	44.1
	ASA III		10	6.6
	ASA IV		01	0.1
Place of incidence	Waiting room		04	2.6
	Operation Theatre		135	88.8
	While shifting patient		05	3.3
	Recovery room (within 1 hour)		05	3.3
Time of incident	Before taking patient into OT		04	2.6
	Before Induction on OT table		06	3.9
	While inducing patient		33	21.7
	While positioning patient		20	13.2
	Intraoperative		72	47.4
	While extubation		10	6.6
	Immediate post-operative		11	7.2
Type of anaesthesia	General	Intubation	65	42.8
		LMA	03	2.0
		TIVA	00	0.0
	Regional	Spinal	12	7.9
		Epidural	01	0.7
		Spinal + Epidural	41	27.0
		Block	19	12.5
	Combined GA + RA		05	3.3
Airway related critical incidents	Dental Injury		01	0.32
	Endobronchial Intubation		03	0.97
	Difficult Intubation		08	2.58
	ETT Disconnection		01	0.32
	Reintubation		03	0.97
	Accidental Extubation		02	0.65
	ETT Displacement		01	0.32
	ETT cuff tear		01	0.32

Maximum number of critical incidents out of 310 incidents was recovery related 80(25.81%). Cardiovascular (17.42%), airway (6.45%) and respiratory (3.87%) related critical incident were the most common. Among the cardiovascular critical incidents, hypotension was the commonest one (10%). Among the neurological critical incidents, seizure and neurological deficit had a single incident each making up 0.32% of total incidents. Out of respiratory related critical incidents, desaturation was maximum 2.58%. The most common physical hazards were intra operative detachment of monitor, disconnection breathing system and electric short circuit with each contributing to 0.65% of total incidents.

The most common metabolic complications we noted was Acidosis (2.58%). The medications related critical incidents were allergic reaction due to antibiotics (1.61%). The most common equipment related critical incidents were laryngoscope malfunction 0.97% of 310 incidents. The most common position related critical incidents were facial swelling 0.65 % due to prone position. Regional related critical incidents contributed to 26(8.39 %) out of 310 incidents. Recovery related critical incidents contributed to 25.81% of which most common was post op ICU requirement in 50 cases. Among the surgeon related critical incident, Class 2 hemorrhage (750-1500ml) was the most common constituting 4.52%. Inadequate starvation and excess starvation were the only patient related critical incidents each constituting 0.32% of the incidents. Miscellaneous critical incidents were 18(5.81%) of which maximum was lost venous access and difficult arterial insertion in 6(1.93%) each (Table 2).

Table 2: Distribution of critical incidents according to occurrence of events

Type of event	Critical incidents	Frequency	Percent
Cardiovascular	Arrhythmia	05	1.61
	Cardiac Arrest	04	1.29
	Myocardial Ischemia	02	0.65
	Myocardial Infarction	01	0.32
	Hypertension	07	2.26
	Hypotension	31	10.0
	Pulmonary embolism	04	1.29
	Total	54	17.42
Neurological	Seizure	01	0.32
	Neurological deficit	01	0.32
	Total	02	0.65
Respiratory	Apnoea	01	0.32
	Bronchospasm	03	0.97
	Desaturation	08	2.58
	Total	12	3.87
Physical Hazards	Electric shock/short circuit	02	0.65
	Cable lines tangled and pulled	01	0.32
	Intraoperative Detachment of monitor	02	0.65
	Disconnection breathing system	02	0.65
	Needle stick injury to doctor	01	0.32
	Total	08	2.59
Metabolic complications	Electrolyte imbalance	01	0.32
	Acidosis	08	2.58
	Hypoglycemia	02	0.65
	Hyperglycemia	02	0.65
	Total	13	4.20
Medications related critical incidents	Wrong route	03	0.97
	Wrong drug	03	0.97
	Wrong label	01	0.32
	Allergic reaction	05	1.61
	Total	12	3.87
Equipment related critical incidents	Laryngoscope Malfunction	03	0.97
	Electricity Problem	02	0.65
	Dislodgement of LMA	01	0.32
	Total	06	1.94
Position related critical incidents	Nerve palsy/Injury	01	0.32
	Facial swelling	02	0.65
	Injuries to another limb	01	0.32
	Total	04	1.29
Regional related critical incidents	Inadequate RA converted to GA	09	2.90
	High Spinal	04	1.29
	Dislodgement of epidural catheter	03	0.97
	LA toxicity	03	0.97

	Dural Puncture		07	2.26
	Total		26	8.39
Recovery related critical incidents	Delayed recovery		06	1.94
	Post op ventilator		24	7.74
	Post op ICU		50	16.13
	Total		80	25.81
Surgeon related critical incident	Hemorrhage	Class 1	05	1.61
		Class 2	14	4.52
		Class 3	13	4.19
		Class 4	09	2.90
	Wrong site		01	0.32
Patient Related critical incidents	Inadequate starvation		01	0.32
	Over starvation		01	0.32
	Total		02	0.65
Miscellaneous	Late/Non-availability of blood		03	0.97
	Hypothermia		02	0.65
	Difficult arterial line insertion		06	1.93
	Lost venous access		06	1.93
	OT Fires		01	0.32
	Total		18	5.81

The Proportion of critical incidents associated with desaturation (n=18), hypotension (n=75) and anaesthesia are shown in table 3.

Table 3: Proportion of critical incidents associated with desaturation (n=18), hypotension (n=75) and anaesthesia

Critical incidents		Frequency	Percent
Desaturation	Dislodgment of LMA	01	5.55
	High Spinal	02	11.12
	Reintubation	01	5.55
	Endobronchial intubation	01	5.55
	Bronchospasm	01	5.55
	Acidosis	01	5.55
	Hypotension	01	5.55
	ETT Disconnection	01	5.55
	LA Toxicity	01	5.55
	Post op ventilator	02	11.12
	Post op ICU	05	27.8
	Class 2 Hemorrhage	01	5.55
Hypotension	Difficult Intubation	01	1.33
	Arrhythmia	03	4.0
	Myocardial Ischemia	02	2.67
	Pulmonary Embolism	02	2.67
	Desaturation	02	2.67
	Cardiac arrest	02	2.67
	Intraop detachment of Monitors	01	1.33
	Electrolyte Imbalance	01	1.33
	Acidosis	02	2.67
	Late or non-availability of blood	02	2.67
	High Spinal	03	4.0
	Post op ventilator	11	14.67
	Post op ICU	23	30.67
	Class 2 Hemorrhage	06	8.0
	Class 3 Hemorrhage	09	12.0
	Class 4 Hemorrhage	05	6.67
Anaesthesia	Recovery (including post-op ICU and Ventilator requirement)	80	25.8
	Cardiovascular	54	17.4
	Surgery related	42	13.5
	Regional	26	8.4
	Airway	20	6.5
	Miscellaneous	18	5.8
	Metabolic	13	4.2
	Respiratory	12	3.9
	Medication	12	3.9
	Physical Hazards	08	2.6
	Equipment	06	1.9
	Surgery postponed	11	3.6
	Position	04	1.3
	Neurological	02	0.6
	Patient related	02	0.6

The outcomes of 152 patients undergoing surgical procedures were noted, which showed that most of the patients recovered fully (94.7%) as depicted in figure 1.

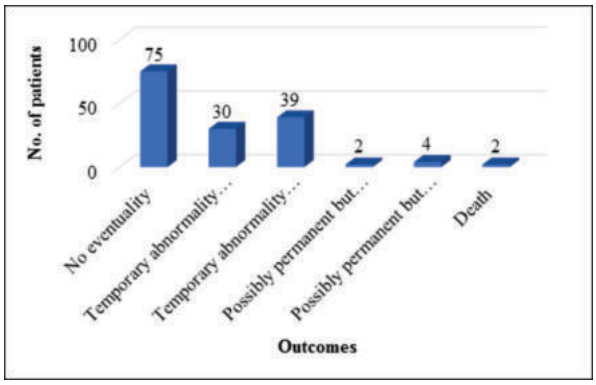

Figure 1: Outcome of 152 patients

Most of the events were preventable (96.05%) either with existing resources (119; 78.29%) or with extra resources (27; 17.76%), as shown in figure 2.

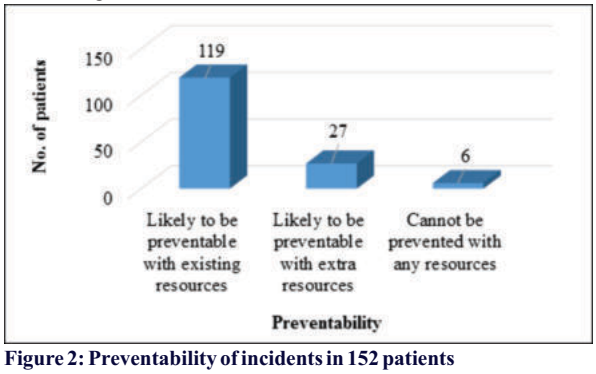

Figure 2: Preventability of incidents in 152 patients

DISCUSSION

In the present study, 152 patients met with 310 critical incidents out of which 46 patients (35.11%) met with more than one critical incident. Out of 310 critical incidents, 57.98% was attributable to anaesthesia, 1.94% was equipment related, 13.55% was surgery related, 0.65% was patient related and 25.88% was recovery related. Maximum patients met with critical incidents in the operation theatre (88.8%) followed by during intra-operative maintenance period (47.4%) and during induction (21.7%). This shows that the 10 minutes of induction period is a high critical incidence zone. These findings related to incidence of critical incidents are correlated with the various other studies [5-8].

Out of 310 critical incidents, 54 (17.42%) were cardiovascular. Incidence of hypotension was 10%. Haemorrhage associated with hypotension was seen in 20 patients and high spinal associated with hypotension in 3 patients. The rest of the cardiovascular incidents included hypertension 7(2.26%), arrhythmias 5(1.61%), cardiac arrest 4(1.29%) and pulmonary embolism 4(1.29%). These findings are comparable with the previous studies [5, 6 8-10]. Orthopaedic procedures are associated with blood loss which may require transfusion of blood and blood products. Anaesthesiologist must anticipate and be prepared for any potential massive blood loss. Adequate blood and blood products must be kept ready. In many patients less blood units were cross matched in view of not anticipating major blood loss, hence there was a delay in getting extra units of blood.

Airway related critical incidents were 20 (6.45%), which included difficult intubation 8(2.58%), reintubation 3(0.97%) and endobronchial intubation 3(0.97%) followed by accidental extubation 2(0.65%), dental injury 1(0.32%), ETT disconnection 1 (0.32%), ETT displacement 1(0.32%), ETT cuff tear 1(0.32%). Critical incidents associated with airway management were found in 17–34% of incidents in other studies [11]. Airway related critical incidents are

common in orthopaedic procedures partly in view of various positions and procedures involving the cervical spine where neck extension is difficult or not possible.

Respiratory related incidents were 12(3.87%), out of which desaturation was seen in 8 patients (2.58%), bronchospasm in 3 (0.97%) and apnoea in 1(0.32%) which is comparable with the study conducted by Gupta S et al [5]. Desaturation was associated with high spinal, reintubation, endotracheal tube displacement, bronchospasm, dislodgement of LMA, hypotension, endobronchial intubation.

Neurological incidents were seen in 2(0.64%) cases, out of which 1 (0.32%) had seizure due to hypoglycemia in the recovery room after the surgery. Whereas neurological deficit incident was seen in 1 patient (0.32%) operated proximal humerus fracture under block. The patient complained of sensory loss of medial part of hand of non-operative side. It was probably position related and inadequate padding of the arm as the recovery happened soon after. Neurological related complications can be intracranial hypertension with deterioration of sensorium, neurological deficit, focal and generalised seizures. The neurological complications during and following surgery depends on procedures and hypoxia, hypoglycaemia, local anaesthesia systemic toxicity, position related neurological deficit, thrombosis. These results are correlated with the study done by Akavipat P [12].

Medication related incidents were 12 (3.87%). Wrong drug administration was seen in 3(0.97%) patients. Allergy to antibiotics was seen in 5(1.61%), wrong route of drug administration in 3(0.97%) and wrong labelling of drug in 1(0.32%). These findings are similar to the study done by Zeng et al [13] and Khan FA et al [14].

Equipment related incidents were 6 out of 310 (1.94%). Laryngoscope malfunction during intubation in 3 (0.97%) cases was the most common equipment related critical incident followed by electricity problem 2(0.65%) and dislodgement of LMA 1(0.46%). Standby spare working laryngoscope was immediately used in these cases. Two (0.65%) incidents related to sudden power outage. No harm was done as power returned immediately. Physical hazards amounted to 8(4.62%) cases. Short circuit was seen in the operation theatre in 2 cases (0.65%). Disconnection of breathing system and intraoperative detachment of monitor was seen in 2 cases (0.65%) each. needle stick injury to anaesthetist, and cable/ lines pulled and tangled seen a case each (0.32%). All 61 monitors should be properly fixed with adhesive tape, so there are no chances of intraoperative hazards. These findings are in accordance with the study conducted by Manghnani PK et al [6] and Cassidy CJ et al [15].

Metabolic complications contributed to 13(4.2%) incidents. Metabolic acidosis was seen in 2.58% (8) out of which acidosis was seen in 1 patient due to major blood loss, in one patient following myocardial ischemia, in two 60 patients who had suffered cardiac arrest and in three patients after endobronchial intubation. Hypoglycaemia was seen in 2 (0.65%) cases. Both patients were known cases of diabetes mellitus. Hypoglycemia was seen in 1 patient in preoperative waiting room and 1 patient had hypoglycemia in post-operative recovery area. Hyperglycaemia was also seen in 0.65%. Both patients were diabetic and with uncontrolled sugars. Insulin was given to control the sugars. The importance of perioperative glucose monitoring holds true in every case.

Miscellaneous critical incidents were 18(5.81%) of which maximum was lost venous access and difficult arterial insertion in 6(1.93%) each followed by late / non-availability of blood in 3(0.97%) and hypothermia in 2(0.65%). Positioning related incidents contributed to 4 out of 310 incidents (1.29%). Facial swelling was seen in 2(0.65%) cases followed by injury to non-operative limb due to position and nerve injury was seen in 1(0.32%) patient each. In literature, the incidence of peripheral nerve injury was observed in 0.03–0.1% and post-operative visual loss in 0.62– 0.2% of patients in spine surgery done in prone position [16].

Regional anaesthesia was given to maximum patients (73), out of which 26 (8.39%) critical incidents were seen. 9(2.9%) patients needed general anaesthesia in view of inadequate action of regional anaesthesia. Dural puncture was seen in 7(2.26%) of the patients. High spinal was seen in 4(1.29%) patients. Dislodgement of epidural catheter while giving position and local anaesthesia toxicity were seen in 3 (0.97%) cases each. This is comparable with the El-Boghdadly K et al study [16]. 24 (7.71%) patients required post-operative ventilator. 50(16.13%) patients required post-operative ICU. Patient factors contributing to incidents were 2 out of 310 (0.64%). Inadequate starvation was seen in a 19-year-old male patient. Patient failed to follow instructions regarding starvation and surgery was postponed since it was an elective case. Excess starvation was seen in a 65-year-old diabetic male as he took the advice of adequate starvation very seriously and stayed nil by mouth for more than 12 hours. Similar findings are reported in Gupta S et al [5] Augbamu et al study [8].

The severity of outcome was analysed which include 49.3% patients were not affected by the critical incident. Temporary abnormality not noticed by patient was seen in 19.7%, temporary abnormality with full recovery was seen in 25.7%, 1.3% patient had permanent but not incapacitating damage and 2.6% of patients had permanent but incapacitating damage and 1.3% patients died. These findings are correlated with the study conducted by Manghnani P et al [6]. Anaesthesiologists tend to report major adverse events rather than minor events [7]. Reporting bias also cannot be excluded. When the anaesthetist knows the outcome of the incident, it influences the judgement and also the evaluation of the critical incident. A possible reason of underreporting by junior resident could also be due to fear of blame by senior anaesthetist, as quite a few cases in elective and most cases in emergency are more commonly managed by junior resident in our institution [17].

Critical incidents are mostly attributable to human error, equipment error or surgical error. Human error may be reduced by being more vigilant, not working for long hours, working under the supervision of seniors and learning from the mistakes. Of the 152 patients, critical incidents were likely to be preventable with existing resources in 78.29%, were likely to be preventable with extra resources in 17.76% and 3.95% were not preventable at all. These results are comparable with the study done by Manghnani P et al [6].

CONCLUSION

Critical incident reporting system can be established based on the data obtained and it should be there in all departments and continued training for such events can reduce severity and frequency of these occurrences. There should be check list and protocols to ensure patient safety and reduce critical events. Anaesthesia related critical incidents should be continued to be reported and analysed to reduce risks and improve patient safety.

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