ORIGINAL ARTICLE

Critical Incident Monitoring in Anaesthesia

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Summary

Critical incident monitoring in anaesthesia is an important tool for quality improvement and maintenance of high safety standards in anaesthetic services. It is now widely accepted as a useful quality improvement technique for reducing morbidity and mortality in anaesthesia and has become part of the many quality assurance programmes of many general hospitals under the Ministry of Health. Despite wide-spread reservations about its value, critical incident monitoring is a classical qualitative research technique which is particularly useful where problems are complex, contextual and influenced by the interaction of physical, psychological and social factors. Thus, it is well suited to be used in probing the complex factors behind human error and system failure. Human error has significant contributions to morbidities and mortalities in anaesthesia. Understanding the relationships between, errors, incidents and accidents is important for prevention and risk management to reduce harm to patients.

Cardiac arrests in the operating theatre (OT) and prolonged stay in recovery, constituted the bulk of reported incidents. Cardiac arrests in OT resulted in significant mortality and involved mostly de-compensated patients and those with unstable cardiovascular functions, presenting for emergency operations. Prolonged-stay in the recovery room was for various reasons: warming up, stabilizing cardiovascular functions with fluid resuscitation and extended period of observation for ill patients. Prolonged stay in recovery was justifiable in some cases, as these patients needed a longer period of post-operative observation until they were stable enough to return to the ward. The advantages of the relatively low cost, and the ability to provide a comprehensive body of detailed qualitative information, which can be used to develop strategies to prevent and manage existing problems and to plan further initiatives for patient safety makes critical incident monitoring a valuable tool in ensuring patient safety. The contribution of critical incident reporting to the issue of patient safety is far from clear and very difficult to study. Efforts to do so have tended to rely on incident reporting, the only practical approach when funding is limited. The heterogeneity of critically ill patients as a group means that huge study populations would be required if other research techniques were to be used. In the era of evidence-based medicine, anaesthetists are looking for alternative evidence-based solutions to problems that we have accepted traditionally when we cannot quantify for good practical reasons. In the quest for patient safety, investment should be made in reliable audit, detection and reporting systems. The growing recognition that human error usually result from a failure of a system rather than an individual should be fostered to allow more lessons to be learnt, an approach that has been successful in other, safety-critical industries. New technology has a great deal to offer and investment is warranted in novel fail-safe drug administration systems. Last but not the least the importance of simple and sensible changes and better education should be remembered.

Key Words: Anaesthetic morbidity, Critical incident reporting, Patients' safety, Human error

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Introduction

The "critical incident technique" was described by Flanagan in 1954, when it was used to reduce loss of military pilots and aircraft during training[1]. Jeffry Cooper in 1978 introduced it into anaesthesia as a method to study errors during administration of anaesthesia[2]. Critical incident reporting is now widely accepted as a useful quality improvement technique for reducing morbidity and mortality in anaesthesia. Despite wide-spread reservations about its value, critical incident monitoring is a classical qualitative research technique which is particularly useful where problems are complex, contextual and influenced by the interaction of physical, psychological and social factors. Thus, it is well suited to be used in probing the complex factors behind human error and system failure. Human error has significant contributions to morbidities and mortalities in anaesthesia. Understanding the relationships between, errors, incidents and accidents is important for prevention and risk management to reduce harm to patients.

Understanding cognitive psychology and its application to study human error is essential for risk management. A near miss is an act of commission or omission that could have harmed the patient, but was prevented from completions through a planned or unplanned recovery. Active error refers to an event occurring immediately before an incident or accident. Errors made may be skill-based or rule-based. Critical incidence monitoring in anaesthesia is not new to our anaesthetic care providers. Several studies were published earlier which stimulated wide interest amongst the clinicians[3,4]. Critical incidence monitoring in anaesthesia has been practised in major general hospital in the government hospital under the Ministry of Health Malaysia.

Materials and Methods

Participating doctors are invited to report any unintended incident, which reduce or could have reduced the safety margin for a patient. Any incident could be reported, not only those which were deemed "preventable" or were thought to involve human error. An audit form is available for data collection. Forms were placed at convenient sites throughout the operation theatre complex. The form contains general instructions to the reporter, key words and space for a narrative of the incident. Structured sections for, "what happened", "why it happened", "when" and "where" the incidence happened. Specific areas of interest are targeted, and details of anaesthesia, monitors used, equipment failure, drug errors, as well as contributing and mitigating factors were recorded. An anaesthetic incident was defined as any incident which affected, or could have affected, the safety of the patient under anaesthetic care. Reporting was voluntary and the identity of the person reporting was kept confidential. Completed forms were deposited into strategically placed boxes from where collection at intervals can be made for final analysis.

Results

The results of critical incident monitoring in a public general hospital in Malaysia (name not revealed to maintain confidentiality) are presented in Table I and II, with the total number of critical incidence from year 2001 to 2005 shown in table III.

* Others included:
- Electricity supply being interrupted (blackout) without prior notice
- Accidental extubation
- Accidental use of N_2O by the surgeon in a case done under local anaesthesia
- Postoperative shoulder pain
- Unjustifiable blood transfusion
- Blood warm up but not used
- Post-extubation restlessness
- Fasting time altered without informing OT staff

Prolonged stayed in recovery longer than two hours was among the highest incidents reported (24 patients) followed by cardiac/respiratory arrest in OT (18 patients). Most of the incidents resulted in morbidity rather the mortality except those that had cardiac arrest on operation table. Out of the 18 cases of cardiac arrest in OT, four were elective cases and 14 patients had emergency operations. Among the elective cases, three patients were successfully resuscitated while the other resulted in death on the operation table. Most of the emergency cases, which were complicated by cardiac arrest on the operation table, ended up as deaths. The majority of these were high-risk patients who were severely injured or had concomitant poor pre-morbid conditions.

Incidents in the recovery room involved the following issues:
- Prolonged stayed in recovery of longer duration than two hours (24 cases)
- One patient who needed control of hypertension

- One patient waiting for cardiac rehabilitation ward (CRW) bed
- One patient awaiting coronary care unit (CCU) bed
- One patient awaiting intensive care unit (ICU) bed
- One patient who needed an ICU bed which was not available at that time
- Four patients who needed correction of hypovolaemia
- Five patients who needed better pain control
- Two patients who developed postoperative confusion
- One patient who developed unexplained arterial blood desaturation
- One patient who developed sudden onset of respiratory distress
- One patient who could not be sent back to ward because the lift was not functioning
- One patient who had sudden upper GI bleeding
- One patient whom the doctor forgot to discharge
- One patient who needed to be warmed up patient
- Two patients who needed management of unstable cardiovascular function

There were five patients who required unexpected reintubation for the following reasons:

- Aspiration pneumonia
- Low Glasgow Coma Score(GCS)
- Hypoventilation secondary to abdominal distension and sudden deterioration of GCS
- Bronchospasm with arterial blood desaturation
- Hypotension and low GCS

Among all the incidents reported, prolonged stayed in recovery seems to have the highest incident reported, 2/3 of them are due to medical reasons and 1/3 of them are due to logistic or administrative problem. Most of them seem to be unavoidable and it is safer to keep the patient longer in the recovery in order to monitor and treat the patient accordingly rather than premature discharge the patient to the ward. There should be better coordination between the ICU/high dependency Ward and the OT in order to reduce the waiting time before transferring the patient to ICU/HDW.

a) Three patients had cardiac arrest in recovery room from the following causes:

- one patient had anaphylactic shock due to intravesicular mitomycin.
- one patient who had above knee amputation was complicated by septic shock.
- one patient whose endotracheal tube was accidentally dislodged during transport.

b) Twelve patients developed unexpected cardiac arrest in operating room with the following details:

- One patient operated for liver laceration which was complicated by 7 litre blood loss.
- One patient who developed cardiac arrhythmias post aortic aneurysm repair and was complicated by sepsis.
- One obstetric patient who had severe pulmonary embolism with acute respiratory distress.
- One patient for leaking aortic aneurysm for emergency repair.
- One paediatric patient with severe pancreatitis complicated by septic shock.
- One patient with ruptured aortic aneurysm for emergency repair.
- One patient with mediastinal tumour and associated bronchial obstruction for elective excision.
- One patient with severe gunshot wound for exploration.
- One patient who suffered polytrauma with associated splenic laceration and fracture of pelvis.
- An elective patient for aortic aneurysm repair complicated by intraoperative myocardial infarction.
- One patient with liver laceration for emergency exploration.
- One patient who had severe sepsis from ventilator associated pneumonia.

c) Eleven patients needed unexpected re-intubation for the following reasons:

- Two patients with acute severe bronchospasm during extubation.
- one paediatric patient who needed ventilation due to opioid related respiration depression.
- one patient who developed sepsis after repair of perforated gastric ulcer.
- one patient who developed stridor secondary to obstruction by fibrin pack after a dental operation.
- one patient who had aspiration pneumonia.
- one patient whose endotracheal tube was obstructed by blood clots.
- One patient who had overdose of muscle relaxant resulting in poor reversal.
- One patient who had associated severe pneumonia as a co-morbid factor.
- One patient with necrotizing fascitis with associated septic shock.
- One patient complicated by the TURP syndrome

Table I: No of anaesthetic incidents reported from January – December 2004

Incidents	Jan	Feb	Mac	Apr	May	Jun	Jul	Aug	Sep	Okt	Nov	Dec	Tot
Cardiac arrest (OT)	2	2	5	1	1	1	2	0	1	1	0	2	18
Reintubation (OT)	0	0	0	0	4	0	0	0	0	0	0	0	4
Reintubation (Rec)	0	1	0	1	0	0	1	0	0	0	2	0	5
Prolonged Stay (Rec)	3	4	1	5	3	1	2	2	1	2	0	0	24
Unplanned to OT 24 hours	0	0	0	0	0	0	0	0	0	1	0	0	1
Fail intubation	1	1	1	0	0	0	0	0	0	2	0	0	5
Airway injury	0	0	1	2	0	0	0	0	0	0	0	0	3
Bronchospams	0	1	0	0	0	0	0	0	0	0	0	0	1
Aspiration	0	0	0	0	0	1	0	0	0	0	0	0	1
Adverse Drug reaction	1	0	0	0	1	0	0	0	0	1	0	0	3
Adverse Tx	1	0	0	0	0	0	0	0	0	0	0	0	1
Medication Error	0	0	1	0	0	1	0	0	1	0	1	0	4
Adverse Outcome for Procedure	0	0	0	0	1	0	0	0	0	0	0	0	1
Myocardial ischaemia	0	1	0	1	1	3	1	0	0	0	0	0	7
Equipment failure			1						1				2
Cancellation of case	1	0	1	0	2	0	0	0	0	0	0	0	4
Misplace blood form	0	0	0	0	1	0	0	0	0	0	0	0	1
*Others	0	0	0	0	0	1	1	1	2	3	1	2	11
Total	**9**	**10**	**11**	**10**	**14**	**8**	**7**	**3**	**6**	**10**	**4**	**4**	**96**

Table II: Critical incident monitoring for 2005

	Jan	Feb	Mac	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	N=
Cardiac arrest (OT)	1	2	1	0	1	1	3	0	0	2	0	1	12
Cardiac arrest (Recovery room)	0	1	0	0	1	1	0	0	0	0	0	0	3
Reintubation	2	0	1	0	1	0	1	1	2	2	0	1	11
Stay > 2 hours (Recovery room)	2	1	0	1	0	3	0	2	3	1	0	0	13
Failed intubation	0	1	0	0	0	0	0	0	0	0	2	1	4
Airway Injury	1	0	0	0	0	0	0	0	0	1	0	1	3
Bronchospasm	0	1	2	0	1	0	0	0	0	0	0	1	5
Adverse drug Reaction	0	0	0	0	0	2	0	0	0	0	0	0	2
Medication Error	1	0	1	0	0	0	0	0	0	0	0	0	2
Myocardial Ischemia	0	0	0	1	0	0	0	1	1	1	0	0	4
Equipment failure	0	0	0	1	0	0	0	0	0	0	1	0	2
Cancellation	0	0	0	1	0	3	3	0	0	0	0	0	7
Aspiration	0	0	1	0	0	0	0	0	0	0	0	0	1
Blood transfusion error	0	0	0	0	0	0	0	0	0	0	1	0	1
Unplanned return to OT (within 24h)	0	0	0	0	0	0	1	0	0	0	2	0	3
Others*	1	0	1	0	0	1	1	1	0	0	0	0	5
Total	8	6	7	4	4	11	9	5	6	7	6	5	78

Table III: Total No of Anaesthetic Incidents: Year 2001 – 2005

Year	2001	2002	2003	2004	2005
No of Incidents	23	32	45	96	78

Discussion

Cardiac arrests in OT and prolonged-stay in the recovery room, constituted the bulk of reported incidents. Cardiac arrests in OT resulted in significant mortality and involved mostly patients presented for emergency operations in de-compensated states. Prolonged-stay in the recovery room were for various reasons: warming up, stabilizing cardiovascular function with fluid resuscitation and prolonged observation of ill patients. Prolonged-stay in recovery was justifiable in some cases as these patients needed a longer period of post-op observation until they were stable enough to return to the ward. We may ask, if these critical incidents are due to human errors? Reason's classification which draws widely from the aviation and nuclear industries as well as medicine[5], divides errors into slips, lapses and mistakes. A slip results from a failure in the execution of an action, whether or not the plan behind it was adequate to reach its objective[5]. Slips are said to be skill-based, occurring during the execution of smooth, automated and highly integrated tasks that do not require conscious control or problem solving[6]. For example, writing the year incorrectly in the date shortly after New Year is a slip. The distinction between a slip and a lapse can be very subtle. Lapses involve memory failure, and may only be apparent to the person who experiences it[5], an example being forgetting to administer antibiotic prophylaxis prior to tourniquet inflation. Latent errors refer to problems lurking within the system causing errors given certain set of circumstances. These errors may be the result of decisions made by managers, designers of equipments and maintenance staff. An example would be an anaesthetic drug trolley loaded with an incorrect drug. An "error script" has been used to illustrate a latent error where human error was made because of exposure to ill designed work environment. The person who committed the error is viewed as a mere player in such a scenario. Modern approach to error views it as a result of interaction between design of activities, procedure and equipments. Under complex environments "normal accident" can happen. Error management strategies include error avoidance, error

trapping and error mitigation. In anaesthesia, routine checking of equipments e.g. anaesthetic machine, could avoid errors. Picking up a wrong syringe or a "syringe swap" is a common occurrence that can be "trapped" by performing a double check or a counter check with a colleague before injecting. Over-generous administration of an induction agent is another pitfall that can be mitigated by using vasopressor drugs to counter the resultant hypotension.

Errors that are currently prominent in people's minds are overestimated compared with those that are less easily recalled. This is referred to as availability bias (also known as exposure or publicity bias) and can be a powerful force. It relates particularly to usually rare, catastrophic or dramatic events. Probabilities of events are upgraded or downgraded according to the ease with which instances of similar events can be recalled. Information availability on a hazard can affect risk perception. In anaesthetic practice, if a patient suffers a complication during a procedure, for example, a pneumothorax after a supraclavicular brachial plexus block, the anaesthetist involved will be much more wary of that complication for the next few blocks performed, although the risk for similar complication is not increased for the next block. "Compression bias" refers to our natural tendency to overestimate rare risks and underestimate common ones. Humans generally have difficulty encompassing the large range of probabilities over which risks can extend. "Miscalibration bias" refers to the tendency for individuals to be overconfident about the extent and accuracy of their knowledge, which tends to desensitise them to the risks concerned. Representative bias refers to a person's tendency to believe that the specific risks for him or her are significantly less than objective probability might suggest; for example, a cigarette smoker who mentally plays down the health risks of smoking because his/her parents have been lifetime smokers and still remain outwardly healthy. Vulnerability is the extent to which people believe an event could happen to them or alternatively is the degree of immunity one possesses to a risk. Many people exhibit unrealistic optimism and a feeling of immunity or invincibility, and this leads them to behave incautiously. Feeling invulnerable, they underestimate or downgrade the risk to themselves but may overestimate the risk to others.

Medication errors

Medication errors are causing a substantial global public health problem, as many result in harm to patients and increased costs to health providers. However, study of medication error is hampered by difficulty with definitions, research methods and study populations. Anaesthetists are not immune from making medication errors and the consequences of their mistakes may be more serious than those of doctors in other specialties. Steps are being taken to determine the extent of the problem of medication error in anaesthesia. New technology, theories of human error and lessons learnt from the nuclear, petrochemical and aviation industries are being used to tackle the problem. Clinical error is a huge global problem. The press and public are unforgiving of those perceived to have harmed patients as a result of seemingly basic mistakes, inattention or carelessness, and equate such mistakes with medical negligence.

Webster and colleagues used a prospective anonymous incident reporting system to establish the frequency of anaesthetic medication error and 'near misses' in two New Zealand hospitals[7]. To improve compliance and provide denominator data, anaesthetists completed a study form whether or not a drug administration error had occurred. Response rates were high and data was collected for 8,000 anaesthetics. The drug administration error rate was 0.75%, with a 'near miss' rate of 0.37%. The most frequent errors were dose errors (20%) and drug substitutions (20%). Most (63%) errors involved intravenous boluses, 20% involved infusions and 15% inhalational agents. This study of medication error in anaesthesia is the only one based on an accurate denominator. Previous studies had used the number of anaesthetics administered during the reporting period as the denominator[8,9], which lacks the benefit of explicitly negative responses and yielded much lower medication error frequencies of 0.012–0.15%. The highest estimate of drug administration error in anaesthesia, 0.75%[7], seems to compare favourably with that of the wards (19%) [10]. However, incident reporting systems are far less sensitive than observational studies. A recent observational study detected 456 errors out of 2557 doses given, but only one of these was detected by a concurrent incident reporting system [11]. Although Webster and colleagues took steps to encourage reporting, it is unclear whether this added any extra sensitivity. There are no direct comparisons of medication error rates in theatre and on the wards and there is little prospect of any in the future.

Detecting anaesthetists' medication errors in the operating theatre presents a particular problem. Review

of drug charts and direct observation are techniques best suited to the wards. Often, anaesthetic drugs are recorded on separate anaesthetic charts rather than patients' drug charts, and anaesthetists prepare and give drugs unsupervised, although practice varies between countries. From a practical point of view, direct observation of an anaesthetist at work would detect far fewer drug administration episodes than the drug round on a busy ward. Despite its limitations, data concerning medication errors in theatres have been collected by incident reporting. Direct observation and drug chart review have been used in critical care.

Critical incident monitoring database

A prospective critical incident reporting system formed the basis of the Australian Incident Monitoring Study (AIMS), which involved anaesthetists from more than 90 hospitals [12]. Analysis of the first 2000 incidents provided data on all aspects of anaesthetic error [13], and although medication error accounted for 7.2% of incidents, none was fatal [14].

Kluger *et al* reported four hundred and nineteen incidents that occurred in the recovery room. Data were extracted from the Anaesthetic Incident Monitoring Study database, representing 5% of the total database of 8372 reports [9]. Incidents were reported mainly in daylight hours, with over 50% occurring in ASA 1-2 patients. The most common presenting problems related to respiratory/airway issues (183; 43%), cardiovascular problems (99; 24%) and drug errors (44; 11%). One hundred and twenty-two events (29%) led to a major physiological disturbance and required management in the High Dependency Unit or Intensive Care Unit. Contributing factors cited included error of judgement (77; 18%), communication failure (57; 14%) and inadequate pre-operative preparation (29; 7%), whilst factors minimising the incident included previous experience (97; 23%), detection by monitoring (72; 17%) and skilled assistance (54; 13%). Staffing and infrastructure of the recovery room needs to be supported, with ongoing education and quality assurance programmes developed to ensure that such events can be reduced in the future.

The anaesthetic incident reporting scheme in Leicester (UK) has been running for 11 years and 1000 incidents have now been reported. The scheme has successfully highlighted weaknesses where a procedural change has been able to prevent repetition. It has provided advance notification of problems which could be overcome by publicity and has been a source of educational cases. The experience of this scheme supports the use of a definition that does not include blame and allows the possibility of anonymous reporting. The scheme has evolved, driven by hospital decisions on reporting risk management cases, by inclusion of the Royal College of Anaesthetists' incident categories and by progressive refinements. Of the 1000 incidents, 731 came from the principal hospital. There were 395 equipment problems, 194 problems involved drugs (often not the primary problem), 402 problems related to the patient, 124 related to organisational problems, 23 to local anaesthesia and 40 to other causes. The patient problem was the primary problem in 76%, while in 24% it was consequent on another. These show marked similarities with previous studies. Adverse events are a major problem for the medical profession. It has been estimated by the US Institute of Medicine that between 44 000 and 98 000 people die each year as a result of medical errors [16], while it has also been estimated that 10%[17]– 17%[18] of patients experience an adverse event during their stay in hospital. The UK government has recently created the National Patient Safety Agency (NPSA), which aims to collect reports of every major adverse event from every hospital.

Singapore critical incident database

An audit of paediatric perioperative incidents in the first 10000 anaesthetics administered in KK Women's and Children's Hospital in Singapore, between May 1997 and April 1999 was under taken[19]. The spectrum of surgery performed ranged from simple ambulatory surgery to open heart surgery for complicated congenital heart diseases. An audit form was completed for every anaesthetic delivered and critical incidents were reported on the reverse blank page of the audit form. An anaesthetic incident was defined as 'any incident which affected, or could have affected, the safety of the patient under anaesthetic care'. Two hundred and ninety-seven critical incidents were reported. The majority of them happened in healthy patients (80.1% ASA I and II) scheduled for elective surgery (73.3%). Critical incidents in infants less than one year of age were four times as common as in older children (8.6% versus 2.1%). Incidents occurred mainly during maintenance (80.6%). There was no anaesthetic mortality. Respiratory events were the most common (77.4%) with laryngospasm accounting for 35.7%. Cardiovascular incidents (10.8%) included hypotension from haemorrhage and sepsis, and dysrrhythmias. The incidence of equipment and pharmacologically related problems was low. Future reviews of a larger patient

population may be helpful to determine trends of perioperative events and whether quality assurance programs have made a difference.

Conclusion

Critical incident monitoring in anaesthesia is an important tool for quality improvement and maintenance of high safety standards in anaesthetic services. It is now widely accepted as a useful quality improvement technique for reducing morbidity and mortality in anaesthesia and has become part of the many quality assurance programmes of many general hospitals under the Ministry of Health. In the Ministry of Health system, steps taken to reduce the number of critical incidences included weekly presentations of mortality and morbidity cases to the whole department. Issues pertaining to each specific case would be brought up, discussed and measures taken to correct any deficiency of care given suggested. For example, regarding the four cases of failed intubation, a small wallet-sized card with grading of larynx and other relevant succinct information patients was given to each to carry at all times. Another area of improvement is the setting-up of pre-anaesthetic clinic, where patients are seen early, to allow pre-operative assessment and optimisation before anaesthesia. This will improved safety tremendously for the high risk patients. The rate of reporting of incidences is improving and this is very encouraging. Improved levels of supervision, care and assessment in the pre-medication rounds, anaesthetic clinic and in the OT together with new protocols and continuous medical education (CME) training sessions for doctors and nurses, continue to contribute to the prevention of critical incidences. Continuing to learn from frequently reported incidences, alerts inexperience and newly trained anaesthetists and helps to improve the standard of patient care.

Critical incident reporting is not without its critics. It often lends itself to criticisms by nature of its method of analysis. Many studies of critical incident encourage voluntary reporting. This method of study creates a self-selected participation where non-responder bias was often a severe criticism towards the validity of the conclusions drawn. Reporting enthusiasm do not sustain long, unless frequent feedback occurs, to stimulate further participation. The content of reported material is subject to personal bias as trivial events are not deemed worthy for reporting. The incessant fear of medico-legal complications as a result of open reporting do not encourage reporting of serious mishaps. The ability to determine an accurate frequency of occurrence of adverse events is difficult due to uncertainty in the denominator population. The contribution of critical incident reporting to the issue of patient safety is far from clear and very difficult to study. Efforts to do so have tended to rely on incident reporting, the only practical approach when funding is limited. The heterogeneity of critically ill patients as a group means that huge study populations would be required if other research techniques were to be used. In the era of evidence-based medicine, anaesthetists are looking for alternative evidence-based solutions to problems that we have accepted traditionally when we cannot quantify for good practical reasons. In the quest for patient safety, investment should be made in reliable audit, detection and reporting systems. The growing recognition that human error usually result from a failure of a system rather than an individual should be fostered to allow more lessons to be learnt, an approach that has been successful in other, safety-critical industries. New technology has a great deal to offer and investment is warranted in novel fail-safe drug administration systems. Last but not the least the importance of simple and sensible changes and better education should be remembered.

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References

1. Flanagan JC. The critical incident technique. Psychological Bulletin 1954; 51: 327-58.
2. Cooper JB, Newbower RS, Long CD, McPeek B. Preventable anesthesia mishaps: a study of human factors. Anesthesiology 1978; 49: 399-406.
3. Choy YC, Lee CY, Jalil N. Critical Incident Monitoring Study. Medical Journal of Malaysia 1996; 51: 234-41.
4. Choy YC, Lee CY, Inbasegaran K. Anaesthesia Incident Monitoring Study in Hospital Kuala Lumpur – The second report. Medical Journal of Malaysia 1999; 54: 4-10.
5. Reason J. Human Error. Cambridge University Press, 1990.
6. Rasmussen J. Information Processing and Human–Machine Interaction. Amsterdam: Holland, 1986.
7. Webster CS, Merry AF, Larsson L, McGrath KA, Weller J. The frequency and nature of drug administration error during anaesthesia. Anaesthesia and Intensive Care 2001; 29: 494-500.
8. Craig J, Wilson ME. A survey of anaesthetic misadventures. Anaesthesia 1981; 36: 933-6.
9. Chopra V, Bovill JG, Spierdijk J. Accidents, near accidents and complications during anaesthesia. A retrospective analysis of a 10-year period in a teaching hospital. Anaesthesia 1990; 45: 3-6.
10. Barker KN, Flynn EA, Pepper GA, Bates DW, Mikeal RL. Medication errors observed in 36 healthcare facilities. Archives of Internal Medicine 2002; 162: 1897-903.
11. Leape LL. Reporting of adverse events. New England Journal of Medicine 2002; 347: 1633-8.
12. Webb RK, Currie M, Morgan CA, *et al.* The Australian Incident Monitoring Study: analysis of 2000 incident reports. Anaesthesia and Intensive Care 1993; 21: 520-8.
13. Fox MAL, Webb RK, Singleton R, Ludbrook G, Runciman WB. Problems with regional anaesthesia – an analysis of 2000 incident reports Anaesthesia and Intensive Care 1993; 21: 646-9.
14. Currie M, Mackay P, Morgan C, *et al.* The Australian Incident Monitoring Study. The 'wrong drug' problem in anaesthesia: an analysis of 2000 incident reports. Anaesthesia and Intensive Care 1993; 21: 596-601.
15. Kluger, MT. Bullock, M F M. Recovery room incidents: a review of 419 reports from the Anaesthetic Incident Monitoring Study (AIMS). Anaesthesia. 2002; 57(11): 1060-6.
16. Helmreich RL. On error management: lessons from aviation. British Medical Journal 2000; 320: 781-5.
17. Vincent C, Neale G, Woloshynowych M. Adverse events in British hospitals: preliminary retrospective record review. British Medical Journal 2001; 322: 517-9.
18. Wilson RM, Runciman WB, Gibberd RW, Harrison BT, Newby L, Hamilton JD. The Quality in Australian Health Care Study. Medical Journal of Australia 1995; 163: 458-71.
19. Tay CL, Tan GM, Ng SB. Critical incidents in paediatric anaesthesia: an audit of 10 000 anaesthetics in Singapore. Paediatric Anaesthesia. 2001; 11(6): 711-8.