

# Anaesthesia Incident Monitoring Study

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## Summary

Critical incident reporting is a very useful technique for reducing anaesthetic morbidity and mortality. It may also be used as a tool for clinical audit at departmental level. Airway incidents constituted the main sector of critical events in our study, consistent with findings reported by morbidity and mortality studies worldwide. Human error was identified as the main factor contributing to the occurrence of adverse incidents. Besides regular morbidity and mortality meetings at departmental level, critical incident monitoring plays an important role in identifying further potential problems. The findings from anaesthesia incident monitoring study (AIMS) can provide detailed qualitative information which can be used to develop strategies to prevent and manage existing problems at both regional and national levels, as well as to plan for further initiatives.

*Key Words:* Anaesthesia, Critical incident monitoring, Quality assurance

## Introduction

The "critical incident technique" was described by Flanagan in 1954<sup>1</sup>, when it was used to reduce loss of military pilots and aircraft during training. Jeffry Cooper in 1978 introduced it into anaesthesia as a method to study errors during administration of anaesthesia<sup>2</sup>. He defined a critical incident as an occurrence that could have led (if not discovered or corrected in time) or did lead to an undesirable outcome, ranging from increased length of hospital stay to death or permanent disability. The "critical-incident" technique was first used to study anaesthesia-related problems in Australia (Townsville) in the early 1980s<sup>3,4</sup>. Subsequently, incident reporting systems were introduced at the Prince of Wales Hospital in Sydney<sup>5</sup> and at the Royal Women's Hospital in Melbourne<sup>6</sup>. The Australian Patient Safety Foundation (APSF) was set up to co-ordinate the Australian Incident Monitoring Study (AIMS) which involved participation of a wide range of hospitals throughout the country<sup>7,8</sup>.

Critical incidents during anaesthesia are currently widely monitored as a form of quality control in many anaesthetic departments. An anaesthetic incident

monitoring study (AIMS) was started in May 1994 as part of the quality assurance programme in both the departments of anaesthesia under Ministry of Health and the Universiti Kebangsaan Malaysia, both based in the Hospital Kuala Lumpur.

## Materials and Methods

The study is modelled on the AIMS study developed in Australia. Participating doctors are invited to report on an anonymous, and voluntary basis, any unintended incident which reduced, 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. A prescribed form is available to facilitate collection of data. This form contains general instructions to the reporter, key words and space for a narrative of the incident, structured sections for what happened (with subsections for circuitry incidents, circuitry involved, equipment involved, pharmacological incidents and airway incidents), why it happened (with subsections for factors contributing to the incident, factors minimising the incident and suggested corrective strategies), the type of anaesthesia and procedure,

monitors in use, when and where the incident happened, the patients' age and a classification of patients' outcome. Strict confidentiality is preserved to avoid the fear of penalty being imposed on the reporting party.

## Results

### Patients' characteristics and case distribution

For the period from May 1994 to June 1995, a total of 185 reports were received. Reports were mainly voluntary, but in some instances the reports made by junior doctors were 'ordered' by senior supervisors in charge of the theatre.

The spread of cases amongst the various disciplines is shown (Table I). When classified according to the American Society of Anaesthesiologists Classification, patients fell into the following groups: ASA I - 129, ASA II - 49, ASA III - 23, and ASA IV - 4. The majority of reported incidents occurred among ASA I patients. From the point of view of age, incidents occurred with the following frequency: patients aged greater than 14 - 144, patients aged 1-14 years - 30, patients aged less than one year - 5 and in neonates - 6. The majority of problems were reported in adults.

### Anaesthesia technique and monitoring

Most of the reports involved elective cases. This is unusual, and strongly suggests under-reporting of incidents occurring during emergency cases. One hundred and seventy eight incidents reported occurred during general anaesthesia, reflecting the dominance of general anaesthesia as the preferred technique. Fourteen incidents occurred in cases under regional anaesthesia or nerve block. Where local infiltration was used only one case was reported in which a critical incident occurred. Many critical incidents were reported in the operation theatre (Table II). There were considerable critical incidents during the induction as well as the maintenance phase of anaesthesia. Surprisingly the incidents reported during recovery from anaesthesia formed a minority (Table III). Problems before induction of anaesthesia did not feature prominently in our study. The majority (167) of the cases reported involved controlled ventilation (IPPV). Ten cases

reported involved spontaneously breathing patients. There were 8 cases where the mode of ventilation was not indicated.

Monitors used in routine cases included pulse oximeter, ECG and non-invasive blood pressure monitors. In ventilated cases additional monitors were used, including auto-disconnect alarm, airway pressure gauge and the capnograph. However the capnograph was

**Table I**  
Distribution of critical incidents by discipline

Discipline	Number	Percentage
Dental	1	0.5
ENT	22	11.9
General Surgical	49	26.5
Gynaecological	18	9.7
Maxillo-facial	1	0.5
Neurosurgical	13	7.0
Obstetric	11	5.9
Ophthalmological	18	9.7
Orthopaedic	30	16.2
Plastic or reconstructive	10	5.4
Urological	7	3.8
Vascular	1	0.5
Other procedure	4	2.2

**Table II**  
Distribution by location where critical incidents occurred

Location	Number	Percentage
Day Surgery	1	0.5
General ward	2	1.1
Intensive care	1	0.5
Operating room	176	95.1
Recovery area	5	2.7

**Table III**  
Phase of anaesthesia during which critical incidents occurred

Phase of anaesthesia	Count	%
Pre-induction	5	2.7
Induction	74	40.0
Maintenance	72	38.9
Emergence	20	10.8
Recovery	9	4.9
Post-recovery	5	2.7

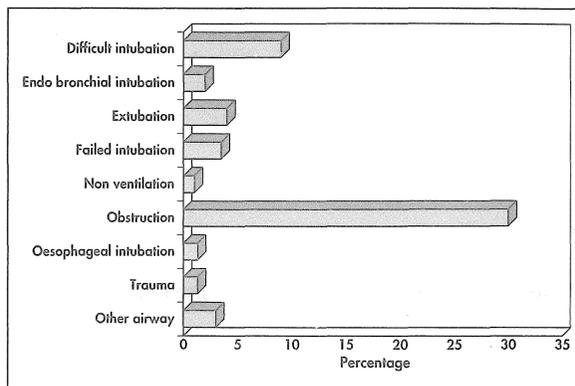
used only when available, as there were insufficient numbers to meet the needs. Depending on clinical indications, additional monitors e.g. intra-arterial blood pressure monitoring, central venous pressure monitoring and others were used.

**Incident categories**

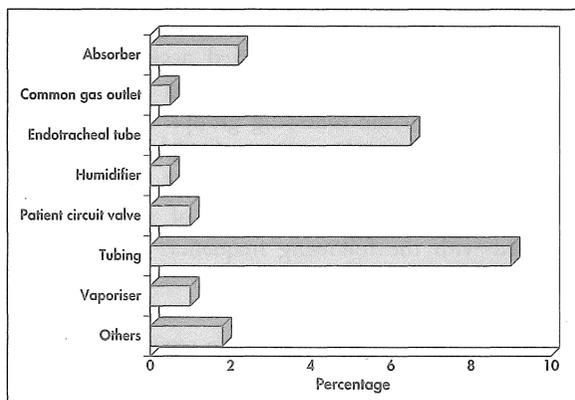
Incidents related to the airway e.g. obstruction of the airway from various causes, formed the bulk of the reported incidents. A lot of these cases were thought to involve bronchospasm from different causes. (Fig. 1). Difficult intubation constituted 8.6% of the 185 incidents reported in our study. Oesophageal intubation constituted 1.6% of the incidents reported in our study. Incidents due to disconnection involving the tubing of the anaesthetic circuits formed the majority of reported cases while involvement of other equipment were as shown in Figure 2.

Most of the incidents involving drugs are indirect effects, e.g. under-dosage of anaesthetic drugs were thought to result in light anaesthesia and bronchospasm. Incidents of giving the wrong drugs were very low (Fig. 3). Anaphylaxis reported in our study involved mainly minor skin manifestation, with no severe or fatal reactions.

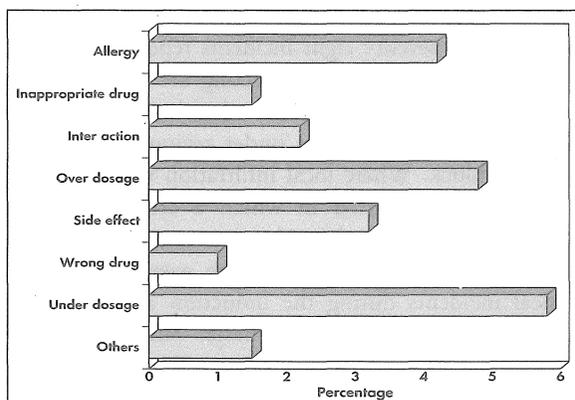
The pulse oximeter was found to be the most useful monitor in terms of the ability to detect any untoward incident occurring during anaesthesia (Fig. 4). The oxygen analyser was not found to be useful for



**Fig. 1:** Airway incidents – critical incidents during anaesthesia where the airway is involved



**Fig. 2:** Circuitry and equipment involved in cases under anaesthesia where critical incidents occurred



**Fig. 3:** Pharmacological incidents – critical incidents where the causes involved drugs

detection of critical incidents during our study. Blood pressure monitoring ranked very low in monitor detection of critical incidents from analysis of our incidents reports. The stethoscope was used in 5.9% of the cases where critical incidents were reported in our study, but was not useful for detection of any of these critical incidents.

Problems associated with vascular access accounted for 1.6% of the incidents in our study. Air embolism was not featured in any of our critical incidents. Three cases of pneumothorax were reported in our study.

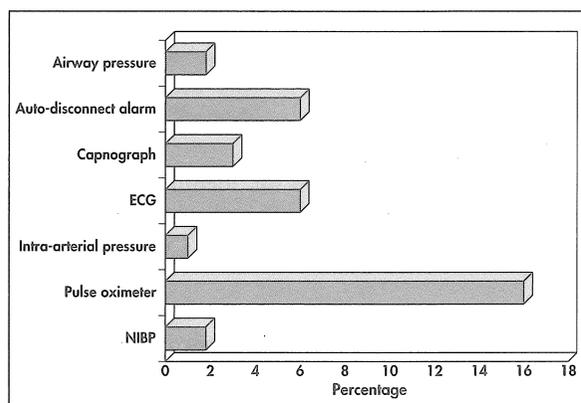


Fig. 4: Monitor detection of critical incidents

**Factors contributing to incident, factors minimising, corrective strategies and outcome**

Error of judgement constituted the greatest factor contributing to the occurrence of critical incidents (Fig. 5 & 6). Monitor detection played a very important role in identifying any untoward incident during anaesthesia, as was the case in this study. A high percentage of incidents (35.7%) was identified by a monitor. Many of the cases involved healthy patients thus severe consequences were not seen (Fig. 7). Quality assurance activities were recognised as very essential to prevent future occurrence of similar incidents. As the definition of critical incident emphasised the importance of trivial events, so the outcome was no untoward effects in 82% of the patients involved. Minor morbidity accounted for 6%, while prolonged stay was recorded in 7% and 2% of patients reported major morbidity. Although there were no adverse outcome in the majority of cases, critical

incident monitoring provides a reasonable indication of what is likely to cause morbidity and death. Death in our report was 2.2%. There was no report of any cases of awareness in our study.

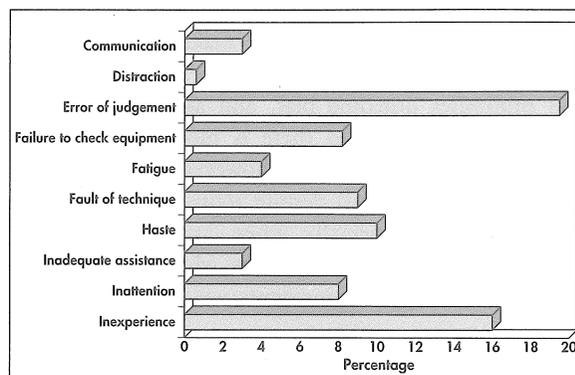


Fig. 5: Factors contributing to occurrence of critical incidents

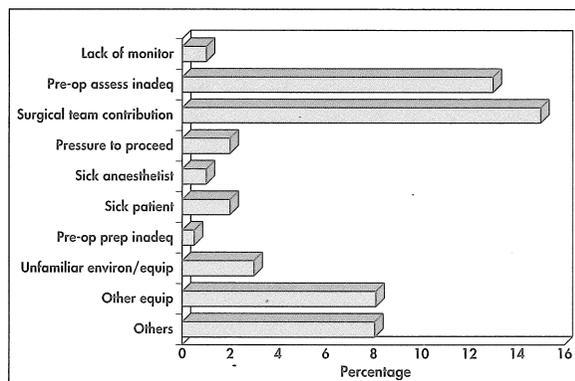


Fig. 6: Factors contributing to occurrence of critical incidents

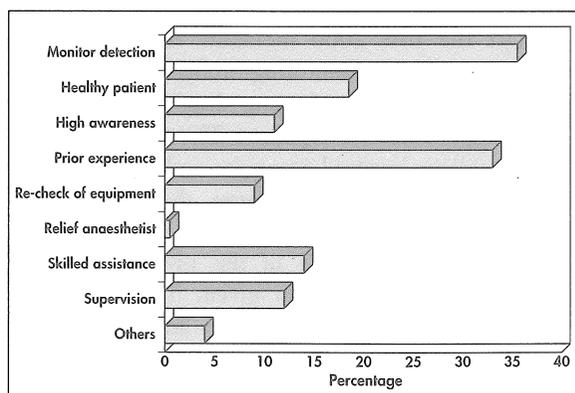


Fig. 7: Factors minimising occurrence of critical incidents

## Discussion

Critical incident reporting has many advantages as a tool for improving safety during anaesthesia. A prescribed form provided for reporting encourages uniform collection of data and makes reporting easy and more systematic. Far better than mortality studies, this minimises outcome bias, and as there is usually no adverse outcome, so there is medico-legal 'safety' for the reporter. In our study however, under-reporting is a significant problem despite active 'encouragement' by supervisors, especially when junior doctors are involved. This probably explains why reports of out of office hours critical incidents were less common.

The majority of incidents involved the airway, in particular airway obstruction. This is consistent with results of morbidity and mortality studies reported in the literature worldwide<sup>2,32,33</sup>. Most of the incidents reported involved general anaesthesia with controlled ventilation, reflecting the current dominance of this technique in our practice. In the Australian Incident Monitoring Study, for the category of airway problems, 9% of incidents involved the endotracheal tube; the commonest of which was endobronchial intubation<sup>13</sup>. Difficult intubation was two times as common as when compared to that reported in the Australian Incident Monitoring Study<sup>21</sup>. The occurrence of oesophageal intubation was comparable with that reported in the Australian Incident Monitoring Study<sup>26</sup>. Several critical incidents involved various equipment, the causes included unfamiliarity with the equipment or sometimes faulty equipment.

Amongst the first 2000 incidents reported to the Australian Incident Monitoring Study, there were 144 incidents in which the "wrong drug" was nearly or actually administered to a patient. Thirty-three per cent of the incidents involved ampoules and just over 40% syringes; in over half of the latter, the syringes were of the same size, and also, in over half, they were correctly labelled. In 81% of the 144 incidents the "wrong drug" was actually given. This was more common with syringes (93%) than ampoules (58%). Thus the most common error was actually giving the wrong drug from a correctly labelled syringe. The most common drug involved was a muscle relaxant in both ampoule and syringe incidents<sup>16</sup>. Our low incidence

did not compare well with the problems reported from Australia, thus may suggest gross under-reporting of pharmacological incidents in our local study. Severe anaphylaxis was not reported in our study, while two deaths related to anaphylaxis were reported in the Australian Incident Monitoring Study<sup>24</sup>. It is also evident that critical incidents occurred as frequently during the induction as well as during the maintenance phase of anaesthesia. In our study, the occurrence of critical incidents during the preoperative phase was low. A number of areas of concern specific to the preoperative period were identified in the Australian Incident Monitoring Study. Inadequate co-ordination between surgical and anaesthetic staff in patient preparation was a frequent cause of preoperative incidents. Improvement in this area may reduce surgical delays and patient morbidity<sup>27</sup>.

The major contributing factor identified is error of judgement, a human error. This displayed similarities between our findings and those of Cooper's original study<sup>2</sup>.

The pattern of monitor usage depended on the clinical situation in each case, although minimal monitoring standards are defined in our routine anaesthetic practice. Monitor detection of adverse events during anaesthesia identified the pulse oximeter to be the most useful individual monitor. In the Australian Incident Monitoring Study; in 52% of the incidents a monitor detected the incident first. The pulse oximeter detected (27%) and together with the capnograph (24%) detected over half of the monitor detected incidents. The oximeter would have detected over 40% of the monitor detected incidents had its more informative modulated pulse tone always been relied upon instead of the "beep" of the ECG<sup>12,15,17</sup>. The oxygen analyser was not useful in detecting critical incidents in our study, but in the Australian Incident Monitoring Study the oxygen analyser detected 1% of the critical incidents, a figure which the authors thought would have been much higher had the oxygen analyser been used on more occasions<sup>28</sup>. Blood pressure monitoring ranked very low in the ability to detect critical incidents in our study, whereas in the Australian Incident Monitoring Study, blood pressure monitoring ranked fourth in monitor detection of critical incidents<sup>19</sup>. The stethoscope was used in 5.9% of the

cases where critical incidents were reported in our study, but was not useful for detection of any of these critical incidents. In the Australian Incidents Monitoring Study it was considered that the stethoscope, used on its own for continuous monitoring, could have detected 54% of the 1256 critical incidents, particularly during paediatric anaesthesia<sup>22</sup>.

Problems associated with vascular access accounted for 1.6% of the incidents in our study; compared with 3% reported in the Australian Incidents Monitoring Study. The anaesthetist should always question the continued integrity of any vascular access system, even when it has recently been shown to be functioning, and the possibility of problems should always be borne in mind. When there is more than one line, all lines and sites of access should be clearly labelled and checked before anything is injected or infused<sup>23</sup>. Air embolism was not featured in any of our critical incidents; while in the Australian Incident Monitoring Study there were 19 cases<sup>29</sup>; this may indicate poor detection of this problem by local anaesthetists. Three cases of pneumothorax were reported in our study, while in the Australian Incident Monitoring Study, 18 cases out of 2000 incidents involved actual or suspected pneumothoraces. Contributing factors identified from the Australian Incident Monitoring Study included urgency, distorted anatomy, failure to check, and haste on the part of the anaesthetist. The possibility of a pneumothorax must always be considered when unexpected cardiorespiratory deterioration occurs<sup>30</sup>. Death in our report was 2.2% compared with 4% reported in the Australian Incident Monitoring Study<sup>20</sup>. Awareness was not reported in our study, although 16 cases in which patient recall of perioperative events, consistent with awareness were reported in the Australian Incident Monitoring Study<sup>31</sup>. Closer monitoring of patients for awareness during the post-operative visits may be necessary, in order not to miss out this important problem. There are also similarities between comparable aspects of the Australian AIMS data and those reported from the USA "closed-claims" studies. For example, the pattern, nature and proportion of the total number of reports is similar for both the USA and the Australian AIMS studies for respiratory complications, recovery room

problems and problems arising during paediatric anaesthesia<sup>11,18,33</sup>.

Factors minimising the occurrence of critical incidents were looked into, and the most important single factor identified was quality assurance activities. Regular morbidity and mortality meeting in the department constitutes an important component in the role of achieving greater safety in anaesthesia practice. On the other hand cases reported in AIMS can be discussed in similar meetings thus ensuring continuous efforts in these activities. However, only about 20% of critical incidents end in morbidity, so by monitoring critical incidents, a better picture may emerge. Therefore, critical incident monitoring should be more widely practised to compliment the usual regular morbidity and mortality meetings.

### Conclusion

Critical incident reporting is a more useful technique for reducing anaesthetic morbidity and mortality compared with existing methods used e.g. case studies during regular morbidity and mortality meetings in many anaesthetic departments. It is highly recommended to be used as a tool for clinical audit at departmental level. The findings from AIMS can provide a detailed qualitative information which can be used to develop strategies to prevent and manage existing problems at both regional and national levels, as well as to plan for further initiatives.

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