

A review on adverse airway events during anaesthesia over 6 years in a tertiary referral hospital

Sangeetha Selvaraj¹ MMED (Anaes), Kah Wei Tan¹ MBBS, Eunice Kok¹ MBBS, Shin Yi Ng¹ MMED (Anaes), Thangavelautham Suhitharan¹ MMED (Anaes)

Dear Editor,

Comprehensive reviews of perioperative critical airway events (CAE) have been conducted through audits and closed claims analyses. However, there is currently limited published data specific to Singapore. Our study aims to analyse CAE at a tertiary hospital in Singapore, ascertain their frequency, identify risk factors, and compare findings to international studies.

We conducted a retrospective review of CAE from January 2014 to December 2019, approved by the SingHealth Centralised Institutional Review Board (2020/2008). We thoroughly reviewed all incident reports in the operating theatre, excluding any intensive care unit (ICU) airway emergency activations. We identified 144 patients, documenting 207 CAE out of 165,253 anaesthesia procedures, equating to an incidence rate of 12.5 CAE per 10,000 anaesthesia procedures. Among these patients, 84 had 1 CAE, 57 patients had 2 CAE, and 3 patients had 3 CAE. The analysis of 144 patients (denominator) revealed that 47.1% were 60 years and above, and the sex distribution was nearly equal. Among the patients, 48.8% were classified as American Society of Anesthesiologists (ASA) score 3 or above. Further, 79.7% of CAE occurred during elective surgeries and within office hours (76.4%). Head and neck surgeries accounted for 26.7% of these events. In addition, 80.1% of patients had adverse events during intubation, with 20.3% undergoing rapid sequence induction. Most CAE happened during anaesthesia induction (34.3%).

We classified complications into immediate and final outcomes, with the immediate outcomes further divided into major and minor categories. The most prevalent complications were hypoventilation or hypoxemia (30.0%), followed by failed extubation requiring re-intubation (15.0%) and aspiration (9.7%). Among the immediate outcomes were 115 minor airway complications and 19 cancelled procedures. Major complications

included 52 unanticipated ICU admissions, 1 case requiring emergency surgical airway creation, and 5 deaths. Two deaths were related to airway management complications, while the other 3 were unrelated to airway management.

A chi-square test compared the general patient cohort with those who experienced CAE. Statistical analysis revealed significant associations between CAE and patients with an ASA status of 3 or higher ($P<0.001$), as well as in cases where anaesthesia was administered after office hours ($P<0.001$). The ASA Closed Claims Project,¹ the NAP4 audit² and research from Australia and New Zealand³ also emphasise the association between higher ASA status, emergency surgeries and CAE.

Several significant findings emerged from our analysis. A considerable number of CAE occurred in head and neck surgeries, likely due to these procedures' specific challenges. Challenges include airway sharing, anatomical distortions, and contamination from surgical debris.⁴ Additionally, most CAE occur during the induction phase of anaesthesia, which is a high-risk period for complications such as hypoxia, aspiration and oesophageal intubation.⁵ However, the study also found significant CAEs during the maintenance and emergence phases, emphasising the need for vigilance throughout the anaesthesia process. Another notable finding was that a minority of CAE occurred in the post-anaesthesia care units, suggesting potential deficits in anaesthetic support or experience within those areas.⁶

The prevalent complications include hypoxemia and hypoventilation,⁷ frequently stemming from challenges in airway management, laryngospasm, bronchospasm, or aspiration. Our study also found that 31 cases required re-intubation, highlighting the potential for airway-related complications post-extubation, which aligns with similar findings by Xie et al.^{3,8} The identified causes of re-intubation were consistent with our findings, encompassing

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¹ Division of Anaesthesiology and Peri-operative Medicine, Singapore General Hospital

Correspondence: Dr Thangavelautham Suhitharan, Department of Intensive Care, Division of Anaesthesiology, Singapore General Hospital.

Email: suhitharan.thangavelautham@singhealth.com.sg

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insufficient reversal of neuromuscular blockade, obstruction in the upper airway, pulmonary oedema and reduced levels of consciousness. Our analysis elicited that CAE were notably prevalent in patients with an ASA status of 3 or higher, possibly attributed to significant functional impairment and systemic illness, aligning with conclusions drawn by Mayhew et al.⁹

Our study also found that the odds of CAE are statistically higher in surgeries performed after 1700 hours compared to the general cohort of patients undergoing surgical procedures (Table 1). This may be attributed to factors such as inadequate manpower, lack of specialist consultant support, fatigue and disrupted circadian rhythms—all of which have been documented to increase anaesthetic adverse events.¹⁰

Table 1. Demographics (n=144) and statistical analysis of the demographics.

	No. of patients	Percentage (%)
Age, years		
<60	64	52.9
60 and above	57	47.1
Not available	23	
Sex		
Male	65	52.8
Female	58	47.1
Not available	21	
ASA score		
1	12	9.6
2	52	41.6
3	51	40.8
4	10	8.0
Not available	19	
Elective/emergency		
Elective	106	79.7
Emergency	27	20.3
Not available	11	
Time of incident		
0800 to 1700 (during office hours)	110	76.4
After 1700 (after office hours)	34	23.6
Location of surgery		
Head + neck	36	26.7
Thorax	13	9.6

Table 1. Demographics (n=144) and statistical analysis of the demographics. (Cont'd)

	No. of patients	Percentage (%)	
Back	6	4.4	
Upper limb	11	8.1	
Upper abdomen	25	18.5	
Lower abdomen	13	9.6	
Genital/gynae	5	3.7	
Urology	7	5.2	
Lower limb	19	14.1	
Not available	9		
Comparing the demographics of patients with critical airway events with the entire cohort of patients who underwent surgery			
	Critical airway events	Total (without critical airway events)	P value
Sex			
Male	65	68,523	0.466
Female	58	69,738	
ASA score			
≤2	64	135,774	<0.001
≥3	61	29,354	
Nature of surgery			
Elective	106	115,080	0.275
Emergency	27	23,171	
Unspecified	11		
Time of incident			
0800 to 1700	110	125,200	<0.001
After 1700	34	14,905	

ASA score: American Society of Anesthesiologists score

Of the 5 deaths, only 2 were attributed to challenging anatomy. The first involved airway burns, where 2 intubation attempts failed, resulting in bradycardia, likely secondary to hypoxia. The proceduralist attempted front-of-neck access, which was unsuccessful despite multiple attempts and complicated by bleeding and aspiration, ultimately resulting in the patient’s demise. While front-of-neck access was necessary, the insertion of a supraglottic airway device should have been considered after the failure of intubation, in line

with the International Difficult Airway guidelines. The second death occurred in a post-coronary artery bypass graft patient, where desaturation after oesophageal intubation led to fatal hypoxia. The other 3 deaths were linked to concomitant cardiac pathologies such as myocardial ischaemia and ventricular fibrillation. These cases underscore the importance of considering contextual factors such as time pressure, remote location, haemodynamic status, and respiratory reserve, all contributing to a “physiologically difficult airway”.

One of our study's key strengths is its large patient population and the structured, anonymised data collection through the Risk Management System, a standardised checklist that ensures reliable reporting. The research team thoroughly reviewed each incident report and reached a collective consensus on the interpretation of the data. The study's retrospective nature is a key limitation, as the anonymised data prevented the collection of further details on CAE and limited the ability to establish temporal sequences or causality. Additionally, some data needed to be more consistently documented, and the administrative nature of the dataset means that some CAEs may not have been consistently registered, potentially leading to an underestimation of the actual incidence of the events.

In conclusion, the study underscores the significant impact of CAE that can occur perioperatively, particularly in head and neck surgeries, after 1700 hours, and in patients with a higher ASA score. These events can lead to severe adverse outcomes, including ICU admissions and fatalities. The research emphasises the significance of comprehensive preoperative evaluation for identifying high-risk patient groups, diligent monitoring during high-risk surgical procedures, adherence to international airway management guidelines, and mandatory participation in advanced airway training programmes. These measures are crucial for improving patient safety and decreasing the occurrence of CAEs. The study also emphasises the need for future research to include prospective studies with more detailed and consistent data collection.

Ethics statement

This study was approved by the SingHealth Centralised Institutional Review Board (2020/2008).

Declaration

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