Victorian Consultative Council on Anaesthetic Mortality and Morbidity

Triennial report 2012-2014



Victorian Consultative Council on Anaesthetic Mortality and Morbidity 2012–2014

Edited by Associate Professor Larry McNicol

Chair of the Victorian Consultative Council on Anaesthetic Mortality and Morbidity

August 2017

To receive this publication in an accessible format phone (03) 9096 8078, using the National Relay Service 13 36 77 if required, or email vccamm@dhhs.vic.gov.au.

Authorised and published by the Victorian Government, 1 Treasury Place, Melbourne.

© State of Victoria, Department of Health and Human Services, August 2017.

Available at www.health.vic.gov.au

Contents

Chair	r's message	7
Exec	utive summary	9
Key fi	indings	10
Reco	mmendations	11
Categ	gorised Clinical Practice Points (CPP)	12
1	About this report	16
2	Reports of mortality and morbidity in 2012–2014	17
2.1	Mortality	18
2.2	Anaesthesia-related deaths	22
2.3	Morbidity	27
3	Analysis of causes of anaesthesia-related mortality and morbidity	
3.1	Perioperative care: Preoperative assessment	32
3.2	Medical condition of the patient	33
3.3	Airway-related events	33
3.4	Aspiration	34
3.5	Cardiovascular events	34
3.6	Drug-related events	36
3.7	Obesity	37
3.8	Postoperative respiratory depression	38
3.9	Procedure-related complications	39
3.10	Respiratory complications other than aspiration	42
3.11	Organisational factors	42
3.12	Perioperative care: postoperative management	43
3.13	Preventability	43
Appe	ndix 1: Definitions of anaesthesia mortality and morbidity	44
Appe	endix 2: Classification of cases reported to the council	45
Арре	ndix 3: Event categories	48
Appe	ndix 4: Preventability score	52
Арре	ndix 5: Council functions	53
Арре	ndix 6: Council membership 2012–2014	54
Appe	ndix 7: Current council membership	55
Appe	endix 8: Current Case Review Subcommittee membership	56
Refer	rences	57

List of tables and figures

Figure 1: Cases reported to the council, 2012–2014	17
Figure 2: Sources of reports in 2012–2014	18
Table 1: Deaths reviewed and classified, 2012–2014	19
Table 2: Primary cause of death, by classification, 2012–2014	20
Figure 3: Deaths by type of surgery, 2012–2014	21
Table 3: Age distribution of all cases of mortality, 2012–2014	22
Table 4: Causal or contributing factors in anaesthesia-related mortality, 2012–2014	23
Table 5: American Society of Anaesthesiologists physical status classification (P)	23
Table 6: Risk in anaesthesia-related deaths, 2012–2014	24
Figure 4: Medical comorbidities and anaesthesia-related deaths, 2012–2014	24
Table 7: Status of the anaesthetist in anaesthesia-related deaths, 2012–2014	25
Figure 5: Location of event, 2012–2014	25
Figure 6: Location of death, 2012–2014	26
Figure 7: Type of hospital where the event occurred, 2012–2014	26
Figure 8: Type of anaesthesia in anaesthesia-related deaths, 2012–2014	27
Table 8: Primary causes of morbidity, 2012–2014	28
Table 9: Causes of anaesthetic-related mortality and morbidity, 2012–2014	

Chair's message

It is a pleasure to present this report, which is derived from information obtained from all case reports submitted to the Victorian Consultative Council on Anaesthetic Mortality and Morbidity (VCCAMM) for anaesthesia-related events that occurred in 2012–2014. The VCCAMM has a proud and long history dating back to its establishment in 1976, and hence for 40 years has been able to provide lessons learned from reviewing collated reports relating to potential anaesthesia deaths and complications.

The speciality of anaesthesia has been a leader among medical disciplines in the field of patient safety, particularly through the process of quality assurance through analysing adverse events. In 1960 the first anaesthesia mortality committee in the world was created when the New South Wales Minister for Health established the Special Committee Investigating Deaths under Anaesthesia and in the mid-1980s the Faculty of Anaesthetists of the Royal Australasian College of Surgeons set about developing a national anaesthesia mortality report. This was initially under the auspices of the National Health and Medical Research Council and subsequently, after the founding of the Australian and New Zealand College of Anaesthetists (ANZCA), through the National Mortality Committee and now the Mortality Sub-committee, which reports to the ANZCA Safety and Quality Committee.^{1–3}

I would like to acknowledge the members of the VCCAMM during the period 2012–2014 (Appendix 5). Their wise and well considered deliberation on all of the cases submitted has provided the peer-review-derived information for this report. I would like to especially acknowledge Dr Patricia Mackay OAM. Pat was my esteemed predecessor. She was a staunch advocate for all aspects of patient safety and a strident supporter of retaining morbidity reporting in anaesthesia. She was Chair of the VCCAMM from 1991 until 2005, and remained on the council as emeritus consultant until October 2014. Sadly, we bade farewell to Pat Mackay in September 2015.

The current Council was appointed in December 2015 with an expanded membership and broader functions that include increased collaboration with other agencies, including the other Consultative Councils and the Victorian Audit of Surgical Mortality of the Royal Australasian College of Surgeons.⁴

I would therefore also like to acknowledge the excellent work of the new VCCAMM members (Appendix 7). The new VCCAMM is not directly involved in case review, so for that purpose we have appointed a case review Subcommittee, which has meets quarterly, and has met thrice during 2016 (Appendix 8). I would especially like to thank the members of this Subcommittee for their important contribution to the work of the Council, in particular the Chair, Dr Andrea Kattula, and the Deputy Chair, Dr Simon Tomlinson.

I would also like to thank my colleagues Professor Jeremy Oats, Chair of the Consultative Council on Obstetric and Paediatric Mortality and Morbidity, and Mr Trevor Jones, Chair of the Victorian Surgical Consultative Council, for their collaboration and friendship, and the whole team of dedicated staff within the Clinical Councils' Unit, led by Manager Vickie Veitch. In particular, I am indebted to senior project officer Hayley Hellinger and project officers Lisa di Tullio and Sarah Kenny for their kindness, loyalty and support.

Finally and most importantly, the landscape for safety and quality assurance in the Victorian healthcare system has very recently undergone major review, and the Department of Health and Human Services is implementing significant changes. The VCCAMM acknowledges and applauds the comprehensive Review of Safety and Quality Assurance in Victoria led by Dr Stephen Duckett and the response by the Minister for Health, the Hon. Jill Hennessy, with the establishment of Safer Care Victoria and the Victorian Agency for Health Information.^{5, 6} We look forward to engagement and collaboration with Safer Care Victoria and congratulate Professor Euan Wallace on his appointment as its inaugural Chief Executive. It is also anticipated that the VCCAMM will interact with the Victorian Health Information Agency and the newly established Victorian Clinical Council. We note and strongly support the establishment of the Ministerial Board Advisory Committee as outlined in the review.

Associate Professor Larry McNicol Chair of the Victorian Consultative Council on Anaesthetic Mortality and Morbidity

Executive summary

Anaesthesia is very safe in Victoria, but there must be improvement in data collection to ensure the calculation of anaesthesia mortality rates is accurate.

Reported deaths associated with anaesthesia in Victoria are extremely rare, with all anaesthesiarelated deaths (categories 1, 2 and 3) occurring at a rate of one death per 118,372 anaesthetics administered.

Notification of all deaths that may be anaesthesia-related is a major priority.

To provide the most accurate estimation of anaesthesia mortality, it is important to collect information on all perioperative and periprocedural deaths and to use the VCCAMM classification system to evaluate the contributory causes for each case.

Analysis of morbidity is very important.

Given the low rates of anaesthesia-related mortality, it is vital to continue to review both mortality and morbidity in order to identify issues for improvement in safety and quality of anaesthesia and perioperative care.

Perioperative patient outcomes are complex and multifactorial.

It is increasingly recognised that perioperative patient outcomes are determined by numerous factors such as: the patient's age and chronic health status; urgency and type of surgery, specific anaesthesia and surgical management; and organisational aspects of perioperative care including type of hospital, staffing and resources.

Collaboration is now required to improve measurement of perioperative outcomes and to provide strategies for better patient care.

Collaboration is needed in all aspects of perioperative outcome measurement, including adverse events, but also in improved patient outcomes from earlier surgical intervention, enhanced recovery programs with early rehabilitation, and intervention to improve chronic health status and quality of life. Shared decision making is essential, including consideration of whether or not surgical intervention is appropriate.

Key findings

Older, sicker patients

It is clear that the causes of the majority of anaesthesia-related deaths are multifactorial in which the outcome is attributed to a combination of anaesthesia, the surgical procedure and the patient's underlying medical conditions. Anaesthesia-related death is more common in older, sicker patients, particular when undergoing emergency surgical procedures.

Anaphylaxis – the pholcodine story

By contrast, primary anaesthesia mortality, where it is reasonably certain that the death was caused by anaesthesia, was most commonly due to anaphylaxis (four of nine category 1 deaths). These allergy-related fatalities were due to the administration of neuromuscular blocking agents (NMBAs). There were also 25 cases of life-threatening morbidity due to anaphylaxis from NMBAs. A higher number of deaths were prevented through early recognition and skilled resuscitation by anaesthetists. Although in current practice these deaths and life-threatening events may be deemed unavoidable, there is emerging evidence that the easy availability of over-the-counter cough mixtures containing pholcodine may be contributing to these anaphylaxis deaths and complications by sensitising patients to the NMBAs.⁷⁻¹⁰

Obesity

Another issue to emerge is the increasing prevalence of obesity. This report identifies an association between obesity and anaesthesia-related complications, including death. This association has multiple components including technical difficulties with airway management, oxygenation and ventilation, intravenous access, and other anaesthesia-related procedures such as epidural and spinal anaesthesia and other nerve blocks. Resuscitation, which requires a range of similar interventional procedures, is also less likely to be successful in very obese patients. Obesity is also an independent risk factor for other diseases including diabetes, cardiovascular disease and sleep apnoea. In seven of the 28 anaesthesia-related deaths in 2012–2014 (25 per cent), obesity was identified as a comorbidity.

Postoperative respiratory depression

An emerging concern is the risk of postoperative respiratory depression, particularly in vulnerable patients with chronic health conditions such as obesity, obstructive sleep apnoea and impaired renal function. These patients are very sensitive to the sedative and respiratory depressant effects of opioid drugs. Of major concern is the frequent failure to provide appropriate facilities and resources for the level of postoperative observation, surveillance and intervention required in these high-risk patients.

Recommendations

Opportunities exist to strengthen the VCCAMM's role as an autonomous quality assurance committee dedicated to collecting, collating and disseminating data on anaesthesia-related mortality and morbidity in Victoria. Recommendations to enhance the functions of the VCCAMM include:

- 1. All Victorian hospitals should be required to notify the VCCAMM within 28 days of any perioperative or periprocedural event that meets the definition for an anaesthesia-related death or major morbidity (Appendix 1). This will enable a more accurate picture of anaesthetic mortality and morbidity in Victoria.
- 2. The VCCAMM should continue to provide anaesthesia mortality data to the Mortality Subcommittee of the Australian and New Zealand College of Anaesthetists (ANZCA) to inform the triennial report Safety of anaesthesia: a review of anaesthesia-related mortality reporting in Australia and New Zealand.
- 3. The VCCAMM should collaborate with other agencies including Safer Care Victoria, the Consultative Council on Obstetric and Paediatric Mortality and Morbidity, the Victorian Surgical Consultative Council, the Victorian Audit of Surgical Mortality of the Royal Australasian College of Surgeons and the Department of Health and Human Services clinical networks to pursue improved perioperative patient outcomes.

In addition, the VCCAMM provides the following recommendations in relation to perioperative care:

- 4. The VCCAMM recommends that all Victorian hospitals develop a strategic approach to the collaborative, multidisciplinary management of elderly frail patients presenting for an emergency procedure, specifically regarding clinical risk assessment and patient wishes (including advance care directives) to reduce the risk of inappropriate or futile intervention.
- 5. The VCCAMM recommends that all Victorian hospitals provide appropriate facilities and resources for the safe perioperative care of patients with morbid obesity, including enhanced surveillance for postoperative respiratory depression and appropriate escalation of care for deteriorating and at-risk patients.
- 6. The VCCAMM should liaise with the Australian and New Zealand Anaesthesia Allergy Group, the Anaesthesia Allergy Subcommittee of ANZCA, the Mortality Subcommittee of ANZCA and the Safety and Quality Committee of ANZCA to lobby the Therapeutic Goods Administration and Medsafe (NZ) to prohibit or restrict inclusion of pholcodine in cough medicines as a specific measure to reduce mortality and serious morbidity due to anaphylaxis caused by neuromuscular blocking agents used during anaesthesia.

Categorised Clinical Practice Points (CPP)

Preoperative assessment and management

CPP 1: Perioperative outcome is strongly influenced by old age, medical comorbidities, emergency surgery and patient frailty. Collaboration is important to ensure the decision to operate is appropriate and takes account of the patient's and carers' wishes, including advance care directives.

CPP 4: It is vital that preoperative assessment identifies key risk factors, particularly in relation to airway management, cardiac disease and obesity, to enable well-planned collaborative perioperative care.

CPP 5: Modern anaesthesia requires careful perioperative management of patients' medical comorbidities.

CPP 6: Preoperative assessment and perioperative care of patients with cardiac disease is generally well managed by anaesthetists.

Surgical procedures

CPP 2: Orthopaedic patients undergoing procedures with a risk of fat or cement embolism must be monitored closely during bone reaming and cement implantation. Invasive arterial pressure monitoring is advised to detect signs of right ventricular dysfunction as early as possible.

CPP 3: During prolonged laparoscopic procedures, there is an increased risk of barotrauma.

Airway

CPP 7: Airway-related adverse events continue to be a frequently reported complication of anaesthesia.

CPP 8: Airway assessment and collaborative planning of airway management in anaesthesia, emergency medicine and intensive care remains a high priority in reducing preventable patient harm.

CPP 9: Mandatory continuous professional development by anaesthetists in all aspects of airway management is of paramount importance.

CPP 10: Obesity is a risk factor for airway-related events and associated sequelae.

Aspiration

CPP 11: Aspiration remains an important cause of death under anaesthesia, and it is essential to modify the choice of technique and its application in patients at high risk.

Cardiovascular

CPP 12: While preoperative assessment and perioperative care of patients with cardiac disease is generally well managed by anaesthetists, arrhythmias remain a significant cause of anaesthesia-related morbidity and potential mortality.

CPP 13: Anaesthetists are highly skilled in managing life-threatening arrhythmias and cardiac arrest.

CPP 14: Mandatory continuous professional development by anaesthetists in the management of cardiac arrest and resuscitation is of paramount importance.

CPP 15: Mandatory continuous professional development by anaesthetists in the management of major haemorrhage and massive transfusion is of paramount importance.

CPP 23: Invasive cardiovascular monitoring is widely regarded as a key component of good anaesthesia care, but it is essential that the risks of vascular injury are minimised.

CPP 24: Monitoring with transoesophageal echocardiography is a key component of modern cardiac anaesthesia, and practitioners are aware of the strategies to reduce the risk of oesophageal injury and intervene early when it may have occurred.

Drugs

CPP 16: The good outcome for the majority of patients exposed to life-threatening perioperative anaphylaxis is due to early recognition and effective crisis management by anaesthetists.

CPP 17: Mandatory continuous professional development by anaesthetists in anaphylaxis crisis management is of paramount importance for perioperative patient safety.

CCP 18: Pholcodine, an adjunct in cough medicines of no demonstrable benefit, increases the risk of life-threatening anaphylaxis to neuromuscular blocking agents used for anaesthesia. The Therapeutic Goods Administration (TGA) should be encouraged to review the evidence in relation to pholcodine and consider regulating the pharmaceutical industry to abolish or restrict its use in Australia.

CCP 19: Drug administration errors continue to be common and are likely to be under-reported. It is vital that anaesthetists recognise the importance of absolute

vigilance during all phases of drug preparation, labelling, storage and administration.

Obesity

CPP 20: Obesity is a major risk factor for anaesthesia and perioperative complications including death. The increasing prevalence of obesity in the community therefore poses a threat to anaesthesia safety.

CPP 29: Hypoxia can occur very rapidly, not only in children but also in obese adults.

Procedures

CPP 25: Due to the potential catastrophic complication of permanent paraplegia, the risk–benefit analysis of placement of epidural or intrathecal catheters must be critically appraised on a case-by-case basis, especially in older patients in whom coagulation status can be less predictable.

CPP 26: It is essential to closely monitor the haemodynamic effect of central neural blockade to ensure appropriate and timely intervention.

CPP 27: Anaesthetists should be proactive in educating all medical practitioners about the safe dose of local anaesthetic agents.

CPP 28: To err is human, but anaesthetists must always remember 'stop before you block' to reduce the risk of procedural error.

CPP 30: It is not appropriate for medical specialists to administer sedation when acting as a sole operator proceduralist.

Organisation

CPP 31: It is essential that clinical anaesthesia service delivery takes into account organisational issues such as staffing, resources, rosters, clinical handover and communication.

Postoperative care

CPP 21: The risk of postoperative respiratory depression associated with opioid analgesia increases in patients with obesity, obstructive sleep apnoea and renal impairment.

CPP 22: All patients' postoperative care must be tailored to take account of the organisational factors such as type of facility, level of nursing care and deployment of tools such as pain management observation charts that include a sedation score.

CPP 32: Increased postoperative surveillance is important to optimise the management of patients' pre-existing comorbidities and any unexpected medical complications.

1 About this report

This report provides an analysis of anaesthesia-related mortality and morbidity from cases submitted to the Victorian Consultative Council on Anaesthetic Mortality and Morbidity (VCCAMM) about events that occurred during 2012–2014. The analysis is derived from council deliberations undertaken after collating the submitted written report and any additional information required to add value to the findings. During this period, cases were fully de-identified before presentation to the council, with only the chair and the project officer being privy to the identity of the patient, the hospital and the reporting practitioner. For reports received via voluntary direct submission from individual anaesthetists, once the council deliberations were completed, the chair provided feedback to the reporting anaesthetist via a confidential letter as part of the peer review process.

The emphasis of the report is on identifying the clinical and system issues that emerge from the case review process. At the completion of the discussion, each case is formally classified, and this includes the allocation of subcategories and keywords. Ten event categories focus on the clinical aspects of anaesthesia-related mortality and morbidity. A full description of the definitions, classification system, event categories and preventability scoring is included in Appendices 1, 2, 3 and 4.

The primary purpose of this report is to inform Victorian anaesthetists about the clinical and system issues that emerge from the review of submitted cases and provide insight into the current major causes of anaesthesia-related mortality and morbidity. This quality assurance activity is designed to improve the safety of anaesthesia and perioperative care. The report also provides the opportunity to liaise with the Department of Health and Human Services and the Minister of Health to plan and implement strategies to improve patient outcomes. Although the content of the report relates to anaesthesia, there is an opportunity to use the data in this report to inform strategic collaboration with other agencies including the other consultative councils, Victoria's clinical networks and the Victorian Audit of Surgical Mortality.

2 Reports of mortality and morbidity in 2012– 2014

The council reviewed 303 cases that occurred in 2012–2014, which comprised 72 deaths, 227 cases of morbidity and four critical incidents (Figure 1).



Figure 1: Cases reported to the council, 2012–2014

The relatively large number of morbidity reports indicates ongoing support for the council's functions from the Victorian anaesthesia community, who recognise the value in analysing morbid adverse events for quality assurance. However, the relatively low number of total mortality cases received might reflect some selectivity in the process of referral of perioperative deaths. A possible explanation may be that hospital anaesthesia departments may not refer cases that are deemed to be inevitable or surgical deaths.

The sources of reports includes direct reports voluntarily submitted by individual anaesthetists, referral of cases that have been reviewed at quality assurance (QA) meetings in hospital anaesthesia departments, as well as coronial referrals and referrals from other sources including medical practitioners such as chief medical officers (Figure 2). It remains of some concern that the council may be under-reporting anaesthesia-related mortality, and the council is currently pursuing enhanced referral of cases by several mechanisms including: improved communication with all Victorian hospitals relating to the obligation to report cases under s. 39 of the *Public Health and Wellbeing Act 2008*; a new collaboration with the Royal Australasian College of Surgeons' Victorian

Audit of Surgical Mortality; increased liaison with the Coroner's Court of Victoria; and (iv) review of Victorian Admitted Episode Data.



Figure 2: Sources of reports in 2012–2014

2.1 Mortality

Total deaths reviewed

The council reviewed 72 deaths from 2012 to 2014. The number of deaths reviewed each year within the threeyear period is listed in Table 1. The classification system used by the council is described in detail in Appendix 2. Of the 72 deaths, 28 (39 per cent) were classified as category 1, 2 or 3 (wholly or partly related to anaesthesia). The numbers of deaths classified as either surgical (category 4) or inevitable (category 5) would be expected to constitute a greater proportion of Victoria's total perioperative mortality than is reflected in the table, which is consistent with the theory that pre-selection of cases deemed suitable for referral to the council occurs. It was not possible to ascertain the autopsy rate for the deaths reviewed in 2012–2014, although it is recognised that the frequency of both coronial and hospital-based autopsy rates has diminished in recent years.

Category	1	2	3	4	5	6-8	Total
2012	4	0	6	6	10	0	26
2013	1	0	8	4	10	3	26
2014	4	1	4	4	5	2	20
Total	9	1	18	14	25	5	72

Table 1: Deaths reviewed and classified, 2012–2014

Anaesthesia mortality rate

The accuracy of data regarding the number of anaesthesia-related deaths (the numerator) is dependent on the council's ability to obtain information on all potential anaesthesia-related deaths in Victoria. Under the current arrangements, cases directly referred to the council are reported voluntarily, and there is some uncertainty about the comprehensive capture of all potential anaesthesia cases from other sources including the coroner and hospital anaesthesia departments. It is therefore reasonably likely that the actual number of anaesthesia-related deaths in Victoria during 2012–2014 was higher than the 28 cases reported here. However, given the longstanding tradition of Victorian anaesthetists reporting cases, it is reasonable to assume that the majority of anaesthesia-related deaths have been identified. Nonetheless, the council will continue to pursue all sources of potential anaesthesia-related deaths, especially through the new collaboration with the Victorian Audit of Surgical Mortality. It is also important to recognise that the council strives to capture cases where the death has occurred outside the operating theatre including sites such as endoscopy rooms, emergency departments and intensive care units. On occasions the administration of anaesthesia, sedation or airway management may have been performed by other (non-anaesthetist) clinicians. The council recognises that such cases need to be captured in anaesthesia-related mortality.

The calculation of anaesthesia mortality rate may be performed by one of two methods, in which the denominator is either the total number of anaesthetics administered, or the total population. The council's preference is the anaesthesia mortality rate based on the total number of anaesthetics administered, and this data is available using the ICD-10 coding obtained from the Australian Institute of Health and Welfare.¹¹ In Victoria there were an estimated 3,314,423 anaesthetics (includes sedation and regional anaesthesia) administered during 2012–2014. This provides an estimated anaesthesia mortality of one in 118,372.

This demonstrates the high level of safety of modern anaesthesia and reflects well on the high standard of anaesthesia training and mandatory continuous professional development coordinated by the Australian and New Zealand College of Anaesthetists (ANZCA). However, it is not unreasonable to target zero in relation to primary anaesthesia-related mortality. This will require ongoing excellence in training and professional development, coupled with further research into safer drugs and anaesthesia techniques.

In the current era, increasingly high-risk procedures are being undertaken in elderly and sometimes frail patients. Modern anaesthesia practice is able to safely ensure that most of these patients will survive the operation. However, given the relatively high number of category 3 deaths in which the death is attributed to a combination of anaesthesia, surgical and patient factors, it is increasingly important to collaboratively assess the appropriateness of some procedures to prevent the risk of a poor outcome and frail patients having potentially futile interventions. In relation to these discussions consideration should be given not only to estimated perioperative risk of death but also other measures such as assessment of 'quality of life adjusted years'. Such discussions would facilitate more meaningful preoperative risk discussions with patients, balancing the anticipated natural history of their current illness and chronic health status against the total risk of a poor perioperative outcome from a surgical or related procedure.¹² There is now increased recognition that old age, the presence of medical comorbidities and patient frailty are major determinants of perioperative outcome, especially in the emergency surgery setting.^{13–18} It is also appropriate to recognise the importance of advance care directives and end-of-life care discussions to empower patients and carers to make informed decisions about high-risk elective and emergency surgical intervention.

Clinical Practice Point 1

Perioperative outcome is strongly influenced by old age, medical comorbidities, emergency surgery and patient frailty. Collaboration is important to ensure the decision to operate is appropriate and takes account of the patient's and carers' wishes, including advance care directives.

Causes of death

The council identified 17 primary causes of death among the 72 classified cases (Table 2). Two cases were classified as category 6 and three as category 7.

Primary cause of death	Cat 1	Cat 2	Cat 3	Cat 4	Cat 5
Airway	1	0	1	0	0
Aspiration	2	0	1	0	1
Bowel infarction	0	0	0	0	2
Cardiac arrest	0	1	2	1	2
Cardiac failure	0	0	5	2	5
Cardiogenic shock	0	0	0	0	1
Drug (anaphylaxis)	4	0	2	0	0
Embolism (amniotic fluid)	0	0	0	1	0
Embolism (cement/fat)	0	0	0	5	0
Haemorrhage	0	0	2	3	5
Hypotension	0	0	2	1	0
Нурохіа	0	0	0	0	1
Myocardial infarct	0	0	3	0	2
Organ failure	0	0	0	0	1
Procedure-related	2	0	0	0	0
Respiratory failure	0	0	0	0	3
Sepsis	0	0	0	1	2
Total	9	1	18	14	25

 Table 2: Primary cause of death, by classification, 2012–2014

Categories 1–3 are anaesthesia-related; category 4 is surgery-related and category 5 is considered inevitable.

Type of surgery

Figure 3 shows deaths by type of surgery. It is noteworthy that endoscopy was the second most common type of procedure. This comprised mostly emergency upper gastrointestinal endoscopy in frail elderly patients, with many classified as inevitable deaths due to haemorrhage or underlying cardiac or respiratory failure. There was one death (category 4 – surgical) due to exsanguination in a patient who had a vascular injury from inserting a trocar for laparoscopic insufflation. There were five surgical deaths attributed to either fat or cement embolism associated with orthopaedic surgery. Anaesthetists must be mindful of this risk, especially during bone reaming and cement implantation. There should be a low threshold for invasive arterial pressure monitoring and vigilance relating to any haemodynamic or gas exchange disturbance, which is likely to signal acute right ventricular dysfunction. One patient suffered a cardiac arrest secondary to systemic absorption of toxic levels of alcohol during a radiological ablation procedure. There were three obstetric deaths, one due to amniotic fluid embolism, another after intervention for postpartum haemorrhage and the third patient suffered seizure and cardiac arrest of unascertained cause.



Figure 3: Deaths by type of surgery, 2012–2014

Clinical Practice Point 2

Orthopaedic patients undergoing procedures with a risk of fat or cement embolism, must be monitored closely during bone reaming and cement implantation. Invasive arterial pressure monitoring is advised to detect signs of right ventricular dysfunction as early as possible.

Age distribution of all cases of mortality

Table 3 confirms the expectation that all mortality (including anaesthesia-related) increases with increasing age. In all categories, 52 (72 per cent) of the deaths were in patients aged over 60 years. In the anaesthesia-related deaths (categories 1, 2 and 3), 18 out of 28 (64 per cent) were older than 60 years of age and 15 out of 28 (54 per cent) were older than 70. These data continue to support the evidence that increased age is a major risk factor for perioperative mortality.¹³

Age	Cat 1	Cat 2	Cat 3	1–3 total (%)	Cat 4	Cat 5	Cat 6-8	Total (%)
0–9				0 (0.0)				0 (0.0)
10–19	1	1		2 (7.1)	2	1	1	6 (8.3)
20–29				0 (0.0)	1			1 (1.4)
30–39			2	2 (7.1)	1			3 (4.2)
40–49	1		1	2 (7.1)		1		3 (4.2)
50–59	1		3	4 (14.3)		1	2	7 (9.7)
60–69			3	3 (10.7)	3	3		9 (12.5)
70–79	3		7	10 (35.7)	1	5	2	18 (25.0)
80–89	3		2	5 (17.9)	4	13		22 (30.6)
90–100				0 (0.0)	2	1		3 (4.2)
Total	9	1	18	28 (100)	14	25	5	72 (100)

Table 3: Age	distribution	of all cases	s of mortality,	2012-2014
			· · · · · · · · · · · · · · · · · · ·	

2.2 Anaesthesia-related deaths

Causal or contributory factors

Multiple factors are implicated in deaths attributable to anaesthesia, and these are described in detail under subcategories in the classification system of Appendix 2. There were 74 contributory factors identified in the 28 cases of anaesthesia-related mortality, representing an average of 2.6 per case.

It is important to identify preventable factors to aid improvement in the anaesthesia mortality rate. In this regard it is noteworthy that in 10 of the 28 deaths (36 per cent), preoperative assessment could have been improved; in 12 of the 28 deaths (43 per cent), there was either poor choice or application of anaesthesia technique and in 10 cases (36 per cent), the management of anaesthesia was not ideal. Organisational factors, such as supervision level or deficiencies in the service provision or team planning, were identified in 11 of the 28 deaths (39 per cent). Drugs contributed to 12 deaths (43 per cent). This included six deaths directly attributable to anaphylaxis, all of which were deemed not to be preventable.

However, it is also important to recognise that the most frequently identified causal or contributory factor in overall anaesthesia mortality is the patient's underlying medical condition (in 16 of the 28 deaths, or 57 per cent), which reflects the increasing number of older, sicker and often frail patients undergoing anaesthesia for surgical or other procedures (Table 4).

Table 4: Causal or contributing factors in anaesthesia-related	mortality, 2012-2014
----------------------------------------------------------------	----------------------

Casual or contributing factor	Number
Pre-operative assessment and/or management (inadequate or inappropriate)	10
Anaesthesia technique	12
Drugs (including adverse drug reactions)	12
Anaesthesia management (crisis management, monitoring, resuscitation)	10
Postoperative care (inadequate or inappropriate)	3
Organisational issues	11
Medical comorbidities	16

The council assigns a preventability rating to all reviewed cases classified as anaesthesia-related (categories 1, 2 and 3). Of the 28 anaesthesia-related deaths, 10 were deemed to be non-preventable (36 per cent).

General risk factors

Level of risk was assigned according to the physical status classification (P) of the American Society of Anaesthesiologists (ASA).¹⁹

ASA or P-1	A normal healthy patient
ASA or P-2	A patient with mild systemic disease
ASA or P-3	A patient with severe systemic disease
ASA or P-4	A patient with severe systemic disease that is a constant threat to life
ASA or P-5	A moribund patient who is not expected to survive without the operation
ASA or P-6	A brain dead patient whose organs are being removed for donor purposes
E	Patient requires an emergency procedure

	.						
Table 5: American	Society of	Anaesthesiologist	ts nhvsica	l status	classification	(P)	1
	0001019 01	/ unacouncerere gio		otatao	olabolilloution	· /	,

In categories 1, 2 and 3 (anaesthesia-related deaths), five of 28 cases (18 per cent) were patients who were healthy or who had mild systemic disease (ASA P-1 and P-2). The remaining 23 of 28 (82 per cent) had severe systemic disease (ASA P-3 and P-4). It is noteworthy that 15 of the 28 cases of anaesthesia-related deaths were in patients undergoing emergency procedures (54 per cent) (Table 6).

Category	1	2	3	Total	%
ASA (P)-1				0	0.0
ASA (P)-2	3	1	1	5	17.9
ASA (P)-3	2		10	12	42.9
ASA (P)-4	4		7	11	39.3
ASA (P)-5				0	0.0
Total	9	1	18	28	100
Emergency	6	1	8	15	53.6

Table 6: Risk in anaesthesia-related deaths, 2012–2014

Medical comorbidities

Fifty-six medical comorbidities were identified in the 28 cases of anaesthesia-related mortality, yielding an average of two medical comorbidities per case. Cardiovascular disease remains the most important risk factor, but it is noteworthy that obesity is the next most prevalent (Figure 4).



Figure 4: Medical comorbidities and anaesthesia-related deaths, 2012–2014

* Other includes endocrine, malignancy, mental disorders, musculoskeletal and neurological diseases.

Status of anaesthetist

It is recognised that specialist anaesthetists are more likely to be involved in the anaesthesia care for more complex high-risk cases (Table 7).

Anaesthetist status	No.
Specialist	25
Non-specialist/GP	0
Trainee	2
Unknown	0
Other*	1

Table 7: Status of the anaesthetist in anaesthesia-related deaths, 2012–2014

* Other: Emergency department intern

Location of event

Of the 28 deaths related to anaesthesia, the event leading to death occurred during induction of anaesthesia in the operating room in six cases (21.4 per cent), in an operating room during surgery in 13 cases (46.4 per cent), in a procedural room in two cases (7.1 per cent), in a post-anaesthesia care unit in three cases (10.7 per cent), in a postoperative general ward in two cases (7.1 per cent), in an intensive care or high dependency unit in one case (3.6 per cent) and in an emergency department in one case (3.6 per cent) (Figure 5).





* Other: Emergency department

Location of death

Of the 28 deaths related to anaesthesia, four occurred in the operating room during induction of anaesthesia (14.3 per cent), seven occurred in the operating room during surgery (25.0 per cent), one occurred in a procedural room (3.6 per cent), two occurred in a post-anaesthesia care unit (7.1 per cent), one occurred in a postoperative general ward (3.6 per cent), 11 occurred in an intensive care or high dependency unit (39.3 per cent), one occurred in an emergency department (3.6 per cent) and one occurred in a palliative care ward (3.6 per cent) (Figure 6).





* Other: Palliative care and emergency department

Type of hospital

Of the 28 deaths related to anaesthesia in 2012–2014, 13 (46.4 per cent) occurred in metropolitan teaching hospitals, nine (32.1 per cent) occurred in regional teaching hospitals, five (17.9 per cent) in private hospitals and one in a rural hospital (Figure 7). It is likely that most complex high-risk cases will be undertaken in either metropolitan or major regional teaching hospitals. It is not possible to comment on the casemix in private hospitals.



Figure 7: Type of hospital where the event occurred, 2012–2014

Type of anaesthesia

The majority of anaesthesia-related deaths (22) occurred in association with general anaesthesia (78.6 per cent). There were two deaths (7.1 per cent) associated with each of combined general and regional, regional anaesthesia alone, and regional anaesthesia with sedation (Figure 8).



Figure 8: Type of anaesthesia in anaesthesia-related deaths, 2012–2014

2.3 Morbidity

Reports of morbidity in 2012–2014

The council considered 227 cases of morbidity from 2012–2014, of which 208 were classified as anaesthesia-related. The majority of the remaining cases were classified as surgical morbidity (Table 8). It is noteworthy that barotrauma related to prolonged laparoscopic procedures is emerging as an important cause of surgical morbidity requiring active management by anaesthetists.

Clinical Practice Point 3

During prolonged laparoscopic procedures, there is an increased risk of barotrauma.

Table	8:	Primary	causes o	f morbidity,	2012–2014
-------	----	---------	----------	--------------	-----------

Event category	Event type (keywords)	Cat 1–3	Cat 4–6	Total	
Airway	Airway (difficult or failed intubation)	11			11
	Airway (injury)	2			2
	Airway (obstruction)	18	2		20
Airway total	-		-	;	33
Cardiovascular	Arrhythmia	17	2		19
	Cardiac arrest	1	1		2
	Embolism (pulmonary)		1		1
	Embolism (fat/cement)		2		2
	Embolism (gas)		1		1
	Haemorrhage	1	1		2
	Myocardial infarct	3			3
Cardiovascular total			•	;	30
Drug-related	Drug (anaphylaxis)	50	1		51
	Drug (allergy)	1			1
	Drug (miscellaneous)	5			5
	Drug error	27		:	27
Drug-related total				;	84
Equipment-related	Equipment	2	2		4
Metabolic	Hypoglycaemia	2	1		3
	Malignant hyperthermia	2			2
Metabolic total					5
Neurological	Inadequate reversal	1			1
	Neuropraxia	2			2
	Transient ischaemic attack	1			1
Neurological total					4
Pain management	Postoperative respiratory depression	6			6
	Other	1			1
Pain management total					7
Procedure-related	Procedural error	7			7
	Monitoring (invasive vascular injury)	5	1		6
	Monitoring (TOE injury)	3			3
	Regional (CNB-related)	10			10
	Regional (nerve block-related)	4			4
	,				

Event category	Event type (keywords)	Cat 1–3	Cat 4–6	Total
Respiratory	Aspiration	16		16
	Barotrauma		3	3
	Bronchospasm	2		2
	Нурохіа	2		2
	Pulmonary oedema	2		2
	Respiratory depression	3		3
	Respiratory arrest	1		1
Respiratory total		29		
Miscellaneous	Sepsis		1	1
	Total	208	19	227

CNB = central neural block; TOE = transoesophageal echocardiography

3 Analysis of causes of anaesthesia-related mortality and morbidity

Council identified 236 cases of anaesthesia-related mortality (28 cases) and morbidity (208 cases). Table 9 includes all keywords that are allocated to each case, and as most cases will be allocated several keywords the number of total number exceeds the number of cases.

Event category	Event type (keywords)	Mortality	Morbidity	Total
Airway	Airway (difficult or failed intubation)	2	11	13
	Airway (injury)		2	2
_	Airway (obstruction)		18	18
Airway total				33
Cardiovascular	Arrhythmia		19	19
_	Cardiac arrest	16	6	22
	Cardiac failure	1	6	7
_	Cardiogenic shock	1		1
	Cardiomyopathy	2	1	3
_	Haemorrhage	4	3	7
_	Hypertension		1	1
_	Hypotension	4	6	10
	Hypovolaemia	1		1
	Myocardial infarct	5	4	9
_	Pacemaker/AICD	1		1
	Vascular	1	5	6
Cardiovascular t	otal			87
Drug-related	Drug (including equipment, local anaesthetic toxicity, metabolic, neurological, overdose, respiratory depression)	1	13	14
	Drug (anaphylaxis)	6	48	54
	Drug (allergy)		1	1
	Drug error		27	27
Drug-related tota	al			96
Equipment	Equipment		10	10
Metabolic	Hypoglycaemia	1	2	3
	Obesity	7	31	38

Table 9: Causes of anaesthetic-related mortal	ity and morbidity, 2012–2014
-----------------------------------------------	------------------------------

Event category	Event type (keywords)	Mortality	Morbidity	Total
	Hypothermia		1	1
	Malignant hyperthermia		2	2
Metabolic total				44
Neurological	Awareness		2	2
	Dystonia (drug effect)		2	2
	Epidural haematoma		2	2
	Inadequate reversal		2	2
	Neuropraxia		3	3
	Post-dural puncture headache		2	2
	Seizure	2	3	5
	Stroke	1	1	2
	Transient ischaemic attack		1	1
	Transient loss of consciousness (procedure-			
	related)		2	2
Neurological tota				23
Pain management	Postoperative respiratory depression		7	7
	Other		1	1
Pain management total				8
Procedure- related	Procedural error		7	7
	Monitoring (invasive vascular injury)	1	5	6
	Monitoring (TOE injury)		3	3
	Regional (CNB-related)	1	10	11
	Regional (nerve-block-related)	1	4	5
Procedure-relate	ed total			32
Respiratory	Aspiration	4	20	24
	Bronchospasm		4	4
	Нурохіа	2	13	15
	Laryngeal mask airway		11	11
	Pneumonia		1	1
	Pneumothorax		1	1
	Pulmonary oedema		7	7
	Respiratory arrest		1	1

Event category	Event type (keywords)	Mortality	Morbidity	Total
	Respiratory depression		10	10
	Respiratory failure		1	1
	Respiratory obstruction		2	2
Respiratory tota	l			77
Miscellaneous	Anticoagulation	1	1	2
	Coagulopathy	1		1
	Handover		2	2
	latrogenic		3	3
	Monitoring	1	7	8
	Obstetric	2	1	3
	Organ failure	2		2
	Posture	1	1	2
	Sepsis	1	1	2
	Transfusion	1		1
Miscellaneous total				26

CNB = central neural block; TOE = transoesophageal echocardiography

Table 9 demonstrates that by allocating event categories using the VCCAMM classification (see Appendix 2) and by describing event types using keywords, the council is able to identify the major clinical issues involved in anaesthesia-related mortality and morbidity. These tools also allow system issues that affect anaesthesia and perioperative outcome to be identified.

3.1 Perioperative care: Preoperative assessment

Historically inadequate preoperative assessment or management has been identified as a key factor in adverse perioperative events, particularly in relation to airway management and cardiac disease. In this report, inadequate preoperative care was identified in 10 of the 28 anaesthesia-related deaths (36 per cent), reinforcing the importance of better planning to reduce preventable mortality. Some of these cases also involved organisational problems. There were only two cases of anaesthesia-related morbidity (of 208) in which preoperative care deficiency was noted. This may be due to the different types of events included in the morbidity case reports.

Clinical Practice Point 4

It is vital that preoperative assessment identifies key risk factors, particularly in relation to airway management, cardiac disease and obesity, to enable well-planned collaborative perioperative care.

3.2 Medical condition of the patient

It is noteworthy that the patient's underlying medical condition was regarded as a contributory factor in the outcome of 16 of the 28 anaesthesia-related deaths (57 per cent) and 32 of the 208 (15.4 per cent) cases of anaesthesia morbidity. This reflects the prevalence of chronic medical illness in the community, particularly in the elderly population. It also demonstrates that modern anaesthesia and perioperative care must take account of the effects of both anaesthesia and the surgical procedure on each patient's specific medical comorbidities.

Clinical Practice Point 5

Modern anaesthesia requires careful perioperative management of patients' medical comorbidities.

Clinical Practice Point 6

Preoperative assessment and perioperative care of patients with cardiac disease is generally well managed by anaesthetists.

3.3 Airway-related events

In 2012–2014 there was one primary anaesthesia death (category 1) in a high-risk patient due to failure to secure an airway; this case was complicated by local bleeding and hypoxic cardiac arrest. Another patient who died from haemorrhage was unable to be intubated during resuscitation attempts prior to emergency surgery. There were 33 airway morbidity reports, six of which were major, including five patients with obesity and obstructive sleep apnoea (OSA). There were four patients who required a surgical airway to salvage a failed intubation scenario, and three of them were obese. One other obese patient required prolonged postoperative intermittent positive pressure ventilation. Another obese patient developed airway problems during general anaesthesia with a laryngeal mask airway (LMA) and, after resolution of bronchospasm, direct laryngoscopy demonstrated a grade 4 view. The patient was allowed to wake up and subsequently underwent surgery under spinal anaesthesia.

There were two cases of failed awake fibre-optic intubation associated with inadequate topical anaesthesia. There were multiple cases of airway obstruction upon emergence from endotracheal anaesthesia, including several in relatively young obese or muscular patients. Light anaesthesia or sedation in the setting of an LMA resulted in airway obstruction requiring intervention in several cases. This was likely to be due to laryngospasm.

There were four airway-related events in infants or children with no adverse sequelae. It is noteworthy that of the 33 morbid airway events, 12 occurred in morbidly obese patients. In 16 of the 33 cases, the event was considered either probably or definitely preventable (48 per cent). There were several cases in which a lack of interdisciplinary planning was identified, including between anaesthesia, ENT and intensive care medical staff. Airway assessment, planning of airway management, repetitive and ongoing training in airway-related procedural skills and crisis management are key priorities for all anaesthetists.^{20–26}

Clinical Practice Point 7

Airway-related adverse events continue to be a frequently reported complication of anaesthesia.

Clinical Practice Point 8

Airway assessment and collaborative planning of airway management in anaesthesia, emergency medicine and intensive care remains a high priority in reducing preventable patient harm.

Clinical Practice Point 9

Mandatory continuous professional development by anaesthetists in all aspects of airway management is of paramount importance.

Clinical Practice Point 10

Obesity is a risk factor for airway-related events and associated sequelae.

3.4 Aspiration

The most frequent and important respiratory complication is aspiration. Aspiration was the direct cause of death in three cases, and in another case death occurred after a difficult intubation in a patient who required an emergency laparotomy and died from haemorrhage. Of the three anaesthesia-related deaths attributed to aspiration, two were in patients at high risk of aspiration during an emergency laparotomy. In one case, the induction of anaesthesia did not involve an appropriate choice of neuromuscular blocking agent (NMBA), and in the other organisational issues led to an unnecessary decision to change the endotracheal tube at the end of the case. The third case involved an urgent gastroscopy in a patient with severe cardiac disease, with aspiration occurring during general anaesthesia with an unprotected airway.

Aspiration was also one of the most frequent causes of anaesthesia morbidity, occurring as the primary event in 16 reports and being part of the outcome in five other cases. All cases involved only minor morbidity and were mostly well managed. In only six of the 16 cases, the aspiration was considered either probably or definitely preventable. There were seven reports of aspiration associated with the use of an LMA, and this is usually attributed to light anaesthesia. LMA was chosen for two paediatric cases undergoing reduction of fractures, and in both cases conversion to endotracheal anaesthesia was required. There were six reports of aspiration during either gastroscopy or colonoscopy.

Clinical Practice Point 11

Aspiration remains an important cause of death under anaesthesia, and it is essential to modify the choice of technique and its application in patients at high risk.

3.5 Cardiovascular events

Arrhythmia

There were no deaths due to arrhythmia but 19 morbidity reports. There were several reports of profound bradycardia attributed to vagal stimulation due to peritoneal insufflation and a variety of other intraoperative arrhythmias including new-onset atrial fibrillation, ventricular tachycardia and ventricular fibrillation. All cases were successfully resuscitated and, on two occasions, patients were subsequently diagnosed with Takotsubo's cardiomyopathy.

Cardiac arrest

There were 16 deaths involving cardiac arrest, and in three cases this was deemed to be the primary cause of death. In the other cases, death was due to anaphylaxis (six cases), aspiration, cardiac failure, hypotension due to myocardial ischaemia, hypoxia, myocardial infarction (two cases), sepsis and systemic local anaesthetic toxicity. In the primary cardiac arrests, the underlying factors were cardiomyopathy and haemorrhage. In the other case, the cause of cardiac arrest was unascertained.

In 13 of the 16 total cardiac arrest cases, there were one or more pre-existing major comorbidities (subcategory H – see Appendix 2). Importantly, the deaths were assessed as not preventable in seven of the total of 16 cardiac arrests. It is also noteworthy that in six of 16 cardiac arrests, the patients were obese, which may reflect a higher prevalence of cardiovascular comorbidities. Resuscitation after cardiac arrest may be less likely to succeed in obese patients compared with non-obese patients. There were two cases of cardiac arrest listed as morbidity, indicating successful resuscitation. In one of these cases, cardiac arrest was attributed to profound respiratory depression after prolonged surgery in a young patient breathing spontaneously during total intravenous anaesthesia.

Clinical Practice Point 12

While preoperative assessment and perioperative care of patients with cardiac disease is generally well managed by anaesthetists, arrhythmias remain a significant cause of anaesthesia-related morbidity and potential mortality.

Clinical Practice Point 13

Anaesthetists are highly skilled in managing life-threatening arrhythmias and cardiac arrest.

Clinical Practice Point 14

Mandatory continuous professional development by anaesthetists in the management of cardiac arrest and resuscitation is of paramount importance.

Haemorrhage

There were three anaesthesia-related deaths due to haemorrhage in which the anaesthesia crisis management was deemed to have contributed to the outcome. In one case, a patient with massive intraabdominal bleeding was unable to be intubated and suffered aspiration and cardiac arrest before surgery had begun. In the other two cases, resuscitation was compromised by morbid obesity.

Clinical Practice Point 15

Mandatory continuous professional development by anaesthetists in the management of major haemorrhage and massive transfusion is of paramount importance.

Myocardial infarction

There were five deaths due to myocardial infarction (MI), and four patients suffered from non-fatal perioperative MI. These data are unsurprising given the prevalence of coronary artery disease (CAD) in the community. Three patients who underwent major surgery for cancer died from cardiac arrest due to perioperative MI. Two of the patients had well documented significant CAD that had been optimised prior to surgery. The other patient had no cardiac history but coronial autopsy revealed severe CAD. One elderly patient required emergency orthopaedic surgery in the context of a recent MI and despite appropriate perioperative care had a further MI after which an advance care directive was followed. These four cases were all managed appropriately, and their deaths were deemed not preventable.

One patient was successfully resuscitated after an intraoperative cardiac arrest due to MI, and two elderly patients had non-fatal postoperative MIs after emergency surgery. Another patient who was successfully resuscitated for cardiac arrest due to anaphylaxis had ECG changes and enzyme rises consistent with MI.

3.6 Drug-related events

There were 54 cases of anaphylaxis, which included six deaths and 48 morbidity reports, many of which were life-threatening. The other common drug-related morbidity was drug error, of which there were 27 reports.

Anaphylaxis

Of the six deaths due to anaphylaxis, two were attributed to suxamethonium, two to rocuronium, one to ceftriaxone and one to either rocuronium or contrast medium. All cases had documented high mast cell tryptase levels, and resuscitation was appropriate in most cases. It is noteworthy that of the six fatal cases, five had underlying conditions that may have affected the outcome. Three patients were elderly, with two also obese. The other elderly patient had coronary artery disease. Of the younger patients, one was also obese and another had a co-existing acute inflammatory condition.

The most frequent trigger agents for the morbidity cases were NMBAs and antibiotics. There were 13 reports for rocuronium, six for suxamethonium, three for atracurium and one for pancuronium (23). There were nine cases attributed to cefazolin, two to ticarcillin-clavulanic acid, and one each to ceftriaxone and ciprofloxacin (13). Other agents included chlorhexidine (three), patent blue V (three), hyaluronidase (two) and gelofusine (one). In the three other cases, the trigger could have been either cefazolin or each of atracurium, rocuronium or patent blue V. In the vast majority of the morbidity cases, it was classified as major and frequently involved profound hypotension and cardiac arrest, as well as in some cases severe bronchoconstriction. The positive outcome in these cases was mostly due to prompt recognition by the anaesthetist and appropriate crisis management, including calling for help, early and escalating administration of adrenaline doses and aggressive fluid administration.²⁷ Resuscitation also frequently involved invasive monitoring, use of adrenaline by infusion and, on the occasions when expertise and equipment were available, monitoring with echocardiography. The VCCAMM notes the extensive work undertaken by the Anaesthesia Allergy Subcommittee of ANZCA and the Australian and New Zealand Anaesthetic Allergy Group (ANZAAG) to provide rapid reference materials to facilitate evidence-based point-of-care crisis management for anaphylaxis.

Clinical Practice Point 16

The good outcome for the majority of patients exposed to life-threatening perioperative anaphylaxis is due to early recognition and effective crisis management by anaesthetists.

Clinical Practice Point 17

Mandatory continuous professional development by anaesthetists in anaphylaxis crisis management is of paramount importance for sustaining perioperative patient safety.

Perioperative anaphylaxis could be considered a non-preventable complication, given that the most frequently involved drugs (NMBAs and antibiotics) are specifically required as part of routine anaesthesia and perioperative care. However, there is emerging evidence that the risk of anaphylaxis due to NMBAs could be significantly reduced in Australia eliminating pholocdine from widely available over-the-counter medications used as cough suppressants. ⁷⁻¹⁰ Pholocdine has the capacity to sensitise patients to the allergenic effects of tertiary and quaternary ammonium compounds including NMBAs. Compelling public health evidence from Scandinavia has demonstrated that removal of pholocdine from cough medicines is associated with reduced prevalence of anaphylaxis to NMBAs. This has been highlighted in recent editorials in *Australian Prescriber* and *Anaesthesia and Intensive Care* and is the subject of considerable focus by the ANZAAG and the Anaesthesia Allergy Subcommittee of ANZCA.^{7,8}

Clinical Practice Point 18

Pholcodine, an adjunct in cough medicines of no demonstrable benefit, increases the risk of life-threatening anaphylaxis to neuromuscular blocking agents used for anaesthesia. The Therapeutic Goods Administration (TGA) should be encouraged to regulate the pharmaceutical industry to review the evidence in relation to pholodine, and consider abolishing or restricting its use in Australia.

Drug errors

There were 27 reports of drug administration errors to the VCCAMM from 2012-2014. The most common events (16 cases) were inadvertent administration of an incorrect drug (syringe swaps). These included NMBAs instead of reversal agents (two cases), midazolam (two) and esmolol. Other drugs given instead of NMBAs included calcium chloride on two occasions and metoclopramide. Cefazolin was given instead of thiopentone; remifentanil and alfentanil were given instead of fentanyl; metaraminol was given instead of cefazolin on two occasions; pancuronium was given instead of suxamethonium; and lignocaine with adrenaline was given intravenously instead of cefazolin. Another very important error was inadvertent postoperative administration of NMBAs due to residual drug being retained in the sidearm or reservoir of an intravenous line or central venous catheter ports. On one occasion, a patient became apnoeic after a residual indwelling intravenous cannula was flushed by the nursing staff. This was most likely to have been due to residual NMBA. In several syringe swap events, there was a failure of communication between two anaesthetists, and this also occurred in relation to handover of care between anaesthetists. Several other drug errors were also attributed to a communication failure between nursing staff and an anaesthetist. There were two cases in which patients suffered from awareness attributed to NMBA syringe swaps, but it is both remarkable and very fortunate that most of these drug errors did not lead to patient harm.

The potential risk of adverse outcomes from drug administration errors during anaesthesia is significant given the range of drugs used – including paralysing agents and potent vasoactive drugs. It is important to recognise that drug administration errors are mostly due to human factors. There has always been debate about the pros and cons of drug checking by a second person, but it is noteworthy that in this report there were multiple occasions when the drug error was at least partly attributed to a communication failure between two anaesthetists, including when both were in attendance, and in other cases, related to handover. The risk versus benefit relating to contingency drug preparation by anaesthetists is also unresolved, but it is imperative that all anaesthetists remain absolutely vigilant during drug preparation, labelling, storage and administration.^{28,29} There has been very little progress in lobbying the pharmaceutical industry regarding the similarity of drug ampoule presentation and labelling, but such efforts should be continued.

Clinical Practice Point 19

Drug administration errors continue to be common and are likely to be under-reported. It is vital that anaesthetists recognise the importance of absolute vigilance during all phases of drug preparation, labelling, storage and administration.

3.7 Obesity

It is widely recognised that there is a worldwide obesity epidemic. This has enormous public health implications as obesity is associated with an increased likelihood of diseases including diabetes and cardiovascular disease. The progressively increasing prevalence of obesity means that obese patients are presenting in greater numbers for anaesthesia and surgery. Obese patients are more likely to require surgery for conditions such as osteoarthritis (including joint replacement). In addition, the evidence for therapeutic benefit from bariatric surgery itself means that increased numbers of obese patients require anaesthesia than ever before. Obese patients are also at increased risk of surgical complications, particularly infection.

Data from this report indicate that obesity is not only a risk factor for other disease but poses a significant additional risk in relation to complications and death from anaesthesia and in the perioperative period. Table 9 shows that obesity was identified as a keyword in 31 cases of anaesthesia-related morbidity and was likely to have contributed to the fatal outcome in 10 of the 28 anaesthesia-related deaths.

This is not surprising and is of very practical importance. Almost all of the technical skills performed by anaesthetists are more difficult in obese patients. These include airway management, intravenous, arterial and central venous access, central neural blockade (epidural and spinal anaesthesia) and regional nerve blocks. Clinical monitoring, including both physical examination and application of body surface and invasive devices, can be less informative due to technical constraints in obese patients. In addition, an obese patient's ability to tolerate the pathophysiological effects of anaesthesia and surgery is significantly compromised. This includes reduced margin of safety for vital functions such as oxygenation and ventilation. Postural requirements for surgery may also impair circulation, particularly the risk of inferior vena caval compression. Resuscitation, which requires a range of similar technical procedures to anaesthesia, is potentially more difficult in very obese patients. Even cardiopulmonary resuscitation, including external cardiac compression, may not be achievable, especially in the super obese. Many obese patients also suffer from OSA, and this poses a major challenge for postoperative care, particularly in relation to their sensitivity to opioid analgesia and the risk of life-threatening postoperative respiratory depression.

Clinical Practice Point 20

Obesity is a major risk factor for anaesthesia and perioperative complications including death. The increasing prevalence of obesity in the community therefore poses a threat to anaesthesia safety.

3.8 Postoperative respiratory depression

Although there were only 10 morbidity cases in which the keywords 'respiratory depression' have been included, this report provides some red flags for this important and potentially lethal postoperative complication. Most of the cases involved organisational failure in postoperative care. There were several reports of either MET calls or code blue calls for unresponsiveness due to excessive opioids, with some patients requiring ongoing intervention with naloxone and ventilatory support. Postoperative analgesia is an important component of perioperative care, and in the modern era, there is a good choice of drugs available to deliver effective pain control. There is an increasing trend towards multimodal drug regimens. However, the inclusion of opioids must take account of a range of patient factors that may lead to untoward effects.

Patients most at risk of inadvertent postoperative respiratory depression are the elderly, the obese, particularly if there is co-existent OSA, and those with impaired renal function. This is an area in which patient risk due to poor organisation of postoperative care must be addressed, including inappropriate choice of facility, inadequate level of nursing care and failure to deploy pain management measurement tools such as charts that include a sedation score.³⁰ The findings of the South Australian coroner into the postoperative deaths of two patients with morbid obesity who underwent orthopaedic surgery in a facility with inadequate postoperative care facilities and resources is a catastrophic example of this risk to patients.³¹ More broadly, there is emerging interest in collaborative approaches involving various models of increased surveillance and intervention in the postoperative period.³² This is an increasingly important component of perioperative medicine that needs to include planned clinical pathways for various types of surgery, with a focus on enhanced recovery programs. These approaches must include adequate but safe methods of analgesia and direct medical input into the management of patients' pre-existing medical conditions, as well as rapid assessment and early intervention for any unexpected medical complications.

Clinical Practice Point 21

The risk of postoperative respiratory depression associated with opioid analgesia increases in patients with obesity, obstructive sleep apnoea and renal impairment.

Clinical Practice Point 22

All patients' postoperative care must be tailored to take account of the organisational factors such as type of facility, level of nursing care and deployment of tools such as pain management observation charts that include a sedation score.

3.9 Procedure-related complications

There were two deaths directly attributable to anaesthesia-related procedures (category 1). In another death in which the cause was unascertained (category 2), cardiac arrest occurred soon after completion of an epidural. One death was due to stroke from unrecognised inadvertent intra-arterial placement of a central venous catheter, and the other case was a cardiac arrest due to systemic local anaesthesia toxicity after placement of a fascia-iliac nerve block performed in an emergency department. There were 32 procedure-related complications including 10 associated with central neural blockade (spinal or epidural), five from invasive monitoring procedures, four involving regional anaesthesia and three injuries due to transoesophageal echocardiography (TOE) monitoring in cardiac surgery. One patient required emergency thoracic surgical intervention to repair an internal jugular vein damaged during insertion of a large bore device (16 Fr fem-flex 11) being placed as part of the planned deployment of veno-venous bypass. There were seven reports of procedural errors involving wrong-side nerve blocks for a variety of techniques. An unusual procedural complication was transient loss of consciousness deemed to be the result of a total spinal after a peribulbar block in which an additional dose of local anaesthetic was administered due to lack of motor block.

Complications of invasive cardiovascular monitoring

Invasive cardiovascular monitoring is widely regarded as an important component of good anaesthesia care for many types of major surgery. It is a commonly held belief that it improves clinical outcome by providing early warning of cardiovascular disturbance to facilitate timely intervention. This is unproven but very likely to be correct. However, it is important to recognise and minimise the risk of patient harm from the monitoring itself. In this report, there were two cases of stroke (one of which was fatal and the other involved major neurological deficit) that were attributed to inadvertent, unrecognised intra-arterial placement of central venous catheters. Acquisition and maintenance of the skills required for insertion and management of invasive cardiovascular monitoring is a key element of anaesthesia training and ongoing performance. However, it is vital that during insertion of central venous access devices, procedures to minimise the risk of inadvertent arterial puncture or catheter placement are deployed. In the event of inadvertent arterial puncture, management should include early referral for vascular surgical advice or intervention.^{33,34} There were two other reports of inadvertent arterial injury during attempted insertion of a central venous catheter, one of which was repaired with placement of an angioseal device by a vascular surgeon.

Clinical Practice Point 23

Invasive cardiovascular monitoring is widely regarded as a key component of good anaesthesia care, but it is essential that the risks of vascular injury are minimised.

Oesophageal injury from monitoring with transoesophaeal echocardiogaphy

Oesophageal injury due to the use of transoesophageal monitoring during cardiac surgery is a recognised complication that has previously been investigated by this council.³⁵ The rate is approximately nine events per 10,000 cases. In this report, there were three patients in whom an

oesophageal injury was noted. In one case, resistance was noted during attempted insertion of the probe. The procedure was abandoned and, after some pharyngeal bleeding, endoscopy revealed a mucosal tear at 20 cm. Cardiac surgery was deferred. A second case involved profound hypotension due to significant upper gastrointestinal bleeding in the early postoperative period. After a massive transfusion during which endoscopy revealed a 1 cm tear at the gastro-oesophageal junction, haemostasis was achieved by placing a clip and there were no further sequelae. The third report involved some blood noted in the nasogastric tube at the end of surgery, and endoscopy revealed only a mild oesophageal abrasion. All cases were managed appropriately.

Clinical Practice Point 24

Monitoring with transoesophageal echocardiography is a key component of modern cardiac anaesthesia, and practitioners are aware of the strategies to reduce the risk of oesophageal injury and intervene early when it may have occurred.

Epidural haematoma after epidural or spinal procedures

There were two reports of spinal cord compression due to epidural haematoma secondary to central neural catheter insertions. One case involved a patient who had normal coagulation status after five days cessation of warfarin and in whom an epidural catheter was inserted prior to general anaesthesia for major abdominal surgery. The patient was stable in the early postoperative period, but there was some uncertainty about the position of the epidural catheter due to some patchy analgesia and the onset of a motor block. After cessation of the epidural infusion, the motor block resolved and it was decided to remove the epidural. As per instructions, the epidural catheter was removed 24 hours after a dose of 20 mg of enoxaparin. Two hours later, another dose of 20 mg of enoxaparin was given, and approximately 12 hours later, the patient rapidly developed a bilateral motor block. Coagulation studies were within normal limits. Cord compression due to epidural haematoma was suspected and urgent transfer to a facility with MRI was arranged. A large thoracic epidural haematoma was confirmed and despite immediate transfer to theatre for spinal decompression, the patient remained paraplegic.

The other case involved an elderly patient in whom an intrathecal catheter was placed to facilitate spinal cord monitoring during deployment of a thoracic endovascular aortic stent. As per protocol, 5,000 units of intravenous heparin was administered two hours after placement of the spinal catheter. Postoperatively the patient's neurological examination was normal, but upon arrival in the intensive care unit, frank blood was noted in the spinal catheter. The catheter was clamped, and the next morning, after confirmation that coagulation tests were normal, the spinal catheter was removed. The patient was well and was transferred to the ward. Two days later, the patient developed buttock pain and leg weakness. Urgent MRI confirmed the presence of an epidural haematoma, and after emergency spinal decompression surgery, the patient made a complete recovery.

Clinical Practice Point 25

Due to the potential catastrophic complication of permanent paraplegia, the risk-benefit analysis of placement of epidural or intrathecal catheters must be critically appraised on a case-by-case basis, especially in older patients in whom coagulation status can be less predictable.

Haemodynamic sequelae of central neural blockade

The haemodynamic effect of a sympathetic block from an epidural and spinal anaesthesia and analgesia is universally recognised. However, there were several cases of unexpected and profound hypotension and cardiovascular collapse in this report. There was one patient in whom the cause of death was unascertained who developed seizure and cardiovascular collapse soon after insertion of an epidural for assisted delivery. It was not possible to identify the mechanism, but a vasovagal reaction to the epidural may have contributed and resuscitation was unsuccessful, with obesity a likely contributory factor in the

outcome. One case involved the sudden onset of nausea, bradycardia, profound hypotension and loss of consciousness soon after incremental administration of 20 mL of 2 per cent lignocaine with 1:200,000 adrenaline administered epidurally for a forceps-assisted delivery. Another patient had an epidural inserted for analgesia during labour and, after 15 mL of 0.2 per cent ropivacaine with 100 mcg of fentanyl, complained of nausea and feeling light-headed. The arterial blood pressure was 80 mmHg and, despite treatment with metaraminol 1 mg, the patient became unresponsive. After brief CPR the patient fully recovered, but due to the onset of fetal bradycardia, urgent LUSCS under general anaesthesia was undertaken. The patient required vasopressor support during the procedure but made a full recovery. A very elderly patient had an epidural inserted prior to an emergency abdominal operation and developed profound hypotension and very high block after a test dose of 3 mL of bupivacaine 0.25 per cent. This was deemed to be an inadvertent subdural or subarachnoid block.

Clinical Practice Point 26

It is essential to closely monitor the haemodynamic effect of central neural blockade to ensure appropriate and timely intervention.

Local anaesthetic toxicity

There was one death directly attributed to cardiac arrest resulting from systemic absorption of local anaesthetic and several case reports of seizure, mostly associated with inadvertent intravascular injection during performance of nerve blocks. The fatal case occurred in an elderly patient with a hip fracture who underwent a fascia iliaca block that was performed by junior medical staff in an emergency department. There were some organisational issues identified that contributed to the outcome. The patient had an advance care plan in place, which was taken into consideration during resuscitation efforts.

In another case in which the cause of death was unascertained, seizure and cardiac arrest occurred soon after insertion of an epidural, and systemic absorption of local anaesthetic was a possible factor. There were two cases of seizure due to local anaesthetic toxicity attributed to inadvertent intravascular injection during lumbar plexus block. In both cases, the dose of local anaesthetic was substantial.

Clinical Practice Point 27

Anaesthetists should be proactive in educating all medical practitioners about the safe dose of local anaesthetic agents.

Procedural errors

Of the reports involving procedural errors, most involved wrong-site regional blocks of which three were interscalene brachial plexus blocks, and there was one each of eye block, fascia iliaca block and femoral nerve block. These occurred during the period when there had been a widespread emphasis on methods to minimise this risk including modification of the anaesthesia check or 'sign in' component of the World Health Organization *Safe surgery checklist*, as well as visual aids such as 'stop before you block' posters.^{36,37}

Clinical Practice Point 28

To err is human, but anaesthetists must always remember 'stop before you block' to reduce the risk of procedural error.

3.10 Respiratory complications other than aspiration

Hypoxia

Hypoxia was identified in 15 case reports, including two deaths and 13 cases with morbidity. The two deaths were due to hypoxic cardiac arrest secondary to failed intubation and loss of the airway in one case and aspiration during upper gastrointestinal endoscopy in the other case. One morbidity case involved a young child who required an adenotonsillectomy for OSA and developed hypoxia during recovery, which was well managed with early intervention including reintubation. There were multiple cases of transient hypoxia related to airway management or aspiration, and most of these were classified as minor. Several of these were in young children. Four major morbidity events occurred in patients with obesity and OSA. In three cases hypoxia developed rapidly during failed airway management, and two of them required an emergency surgical airway. The fourth patient became hypoxic after upper airway surgery and required reintubation and two days of postoperative ventilation.

Clinical Practice Point 29

Hypoxia can occur very rapidly, not only in children but also in obese adults.

Pulmonary oedema

There were seven cases of major morbidity involving acute perioperative pulmonary oedema. Two of them were attributed to fluid overload and probable diastolic dysfunction. One patient was obese and the other had underlying sepsis. There were three cases of negative pressure pulmonary oedema that occurred secondary to airway obstruction during emergence from endotracheal anaesthesia. All were young males with a muscular physique. The other cases both occurred after resuscitation for intraoperative asystolic cardiac arrest secondary to vagal stimulation from pneumoperitoneum and visceral traction during upper abdominal surgery. Echocardiography in each case showed global left ventricular dysfunction with subsequent recovery, consistent with a diagnosis of Takotsubo's cardiomyopathy.

Respiratory depression

Postoperative respiratory depression has been discussed above, but there was one report of a respiratory arrest that occurred during sedation administered by a respiratory physician who was also performing the fibre-optic bronchoscopy. Nursing staff noted the patient was unresponsive and apnoeic and called for assistance from an anaesthetist.

Clinical Practice Point 30

It is not appropriate for medical specialists to administer sedation when acting as a sole operator proceduralist.

3.11 Organisational factors

Problems related to organisational issues such as: inadequate supervision, inexperience or assistance; poor service provision or lack of communication; or failure of interdisciplinary planning were identified in 11 out of the 28 anaesthesia-related deaths (21.4 per cent) and 28 out of 208 anaesthesia-related morbid adverse events (13.5 per cent). It is recognised that hospitals are large complex institutions and hence there is always the potential for organisational failure contributing to adverse patient outcomes. It is therefore essential that clinical anaesthesia service delivery takes account of organisational issues regarding management of rosters, staffing, handover and communication.

Clinical Practice Point 31

It is essential that clinical anaesthesia service delivery takes into account organisational issues such as staffing, resources, rosters, clinical handover and communication.

3.12 Perioperative care: postoperative management

Inappropriate or omission of active intervention in the postoperative period was identified in three of the 28 anaesthesia-related deaths (10.7 per cent) and 14 of the 208 morbid adverse events (6.7 per cent). Although these rates are relatively low numerically, they are important red flags for an increasing level of postoperative risk. Many of these cases also included organisational problems. It must be recognised that patients are most at risk in the postoperative period when the level of observation and opportunities for early intervention are sometimes limited by resources, staffing and experience. This is most applicable to patients at risk of opioid-induced postoperative respiratory depression, including the obese, especially if OSA co-exists, and renal impairment. It is also a period when patients are at risk of cardiac events.

Clinical Practice Point 32

Increased postoperative surveillance is important to optimise the management of patients' pre-existing comorbidities and any unexpected medical complications.

3.13 Preventability

In 2012 the council adopted a preventability scoring system that is applied to all cases that are reviewed and classified as anaesthesia-related (categories 1, 2 and 3). A description of the preventability scoring system is included in Appendix 4. In brief, there are four grades of preventability ranging from definitely not (0) to possibly (1), probably (2) and definitely (3) preventable. Analysis of all mortality and morbidity reports has identified that 10 of the 28 anaesthesia-related deaths (35.7 per cent) were deemed not preventable. This is reasonable and reinforces the fact that most deaths were category 3 in which factors beyond the control of the anaesthetist, mostly the patient's age, underlying medical status and type of surgery, were contributory. On the other hand, in seven of the 28 mortality cases (25 per cent), preventability was rated either probably or definitely, indicating room for improvement in some component of anaesthesia care. Of course the target for preventable anaesthesia-related mortality should be zero. Of the 208 reports of anaesthesia-related morbidity, 74 (35.5 per cent) were deemed not preventable and 87 (41.8 per cent) were regarded as either probably or definitely preventable.

This report has already noted the importance of maintaining the highest standards of anaesthesia training and safety through continuous professional development, but this must be combined with research to find even safer drugs and techniques. In this report, there were at least 27 cases of anaphylaxis triggered by NMBAs, four of which were fatal and 23 (up to 25) resulted in life-threatening morbidity. It is likely that a significant number of these deaths and near death episodes could have been avoided by preventing exposure to pholcodine, an adjunct of doubtful efficacy currently available as a component of over-the-counter cough medicines. Pholcodine has been shown to cause cross-sensitisation to the allergenic effects of NMBAs, and hence it is timely for the TGA to review the evidence for its unrestricted availability. This could reduce the risk of anaphylaxis to NMBAs and further reduce preventable anaesthesia-related harm.

Appendix 1: Definitions of anaesthesia mortality and morbidity

The council defines 'anaesthesia-related mortality' as one of the following:

- a death that occurs during an operation or procedure (or within 24 hours of its completion) performed with the assistance of sedative, analgesic, local or general anaesthetic drugs or any combination of these
- a death that may result (either partially or totally) from an incident during or after such an operation or procedure, even if more than 24 hours have elapsed since its completion.

In the event of an anaesthesia-related death, the following information should be forwarded to the VCCAMM within 28 days of the death:

- the anaesthesia record
- the preoperative assessment, including medical comorbidities, previous surgical history, current medications, investigations, airway or other anaesthesia issues, etc.
- the operation or procedure report
- a summary of postoperative events, including ICU/HDU if relevant
- any relevant postoperative investigations
- a copy of the eMedical deposition to the coroner if applicable
- other relevant data and/or documents, including age, gender, ASA-P classification, elective or emergency status, location of the event leading to death, and the location of death.

The council defines 'anaesthesia-related morbidity' as any event related to an anaesthetic procedure that causes a life-threatening incident, temporary or permanent disability, or significant distress. Morbidity is categorised as 'major' or 'minor' according to its severity or outcome.

In the event of an anaesthesia-related morbidity, the following information should be forwarded to the VCCAMM within 28 days of the adverse event:

- the anaesthesia record
- the preoperative assessment, including medical comorbidities, previous surgical history, current medications, investigations, airway or other anaesthesia issues, etc.
- the operation or procedure report
- a summary of postoperative events, including the intensive care unit or high-dependency unit if relevant
- any relevant postoperative investigations
- details of the clinical outcome from the adverse event
- any other relevant data and/or documents, including age, gender, ASA-P classification, elective or emergency status, and the location of the event.

Appendix 2: Classification of cases reported to the council

Categories of mortality and morbidity

Deaths or morbidity attributable to anaesthesia

Category 1	Where it is reasonably certain that death or morbidity was caused by the anaesthesia or other factors under the control of the anaesthetist.
Category 2	Where there is some doubt whether death or morbidity was entirely attributable to the anaesthesia or other factors under the control of the anaesthetist.
Category 3	Where death or morbidity was caused by both medical/surgical and anaesthesia factors.

Death or morbidity in which anaesthesia played no part

Category 4	Surgical death or morbidity where the administration of the anaesthesia was not contributory and surgical or other factors are implicated.
Category 5	Inevitable death or morbidity that would have occurred irrespective of anaesthesia or surgical procedures.
Category 6	Fortuitous death or morbidity that could not reasonably be expected to have been foreseen by those looking after the patient and was not related to the indication for surgery and was not due to factors under the control of the anaesthetist or surgeon.

Unassessable death/morbidity

Category 7	Those that cannot be assessed despite considerable data but where the information is conflicting or key data is missing.
Category 8	Cases that cannot be assessed because of inadequate data.
Category 9	A critical incident where a problem is identified but no morbidity occurs.

Causal or contributory factors in anaesthesia-related mortality and morbidity subcategories

A. Preoperative

(i)	Assessment	This may involve failure to take an adequate history or perform an adequate examination or to undertake appropriate investigation or consultation or make adequate assessment of the volume status of the patient in an emergency. Where this is also a surgical responsibility the case may be classified as category 3.
(ii)	Management	This may involve failure to administer appropriate therapy or resuscitation. Urgency and the responsibility of the surgeon may also modify this classification.

B. Anaesthesia technique

(i)	Choice or application	There is inappropriate choice of technique in circumstances where it is contraindicated or by the incorrect application of a technique that was correctly chosen.
(ii)	Airway maintenance including pulmonary aspiration	There is inappropriate choice of artificial airway or failure to maintain or provide adequate protection of the airway or to recognise misplacement or occlusion of an artificial airway.
(iii)	Ventilation	Death or morbidity is caused by failure of ventilation of the lungs for any reason. This would include inadequate ventilator settings and failure to reinstitute proper respiratory support after deliberate hypoventilation (for example, bypass).
(iv)	Circulatory support	Failure to provide adequate support where there is haemodynamic instability, in particular in relation to techniques involving sympathetic blockade.

C. Anaesthesia drugs

(i)	Selection	Administration of a wrong drug or one that is contraindicated or inappropriate. This would include 'syringe swap' errors.
(ii)	Dosage	This may be due to incorrect dosage, absolute or relative to the patient's size, age and condition and in practice is usually an overdose.
(iii)	Adverse drug reaction	This includes all fatal drug reactions, both acute such as anaphylaxis and the delayed effects of anaesthesia agents such as the volatile agent.
(iv)	Inadequate reversal	This would include relaxant, narcotic and tranquillising agents where reversal was indicated.
(v)	Incomplete recovery	For example, prolonged coma.

D. Anaesthesia management

(i)	Crisis management	Inadequate management of unexpected occurrences during anaesthesia or in other situations that, if uncorrected, could lead to death or severe injury.
(ii)	Inadequate monitoring	Failure to observe minimum standards as enunciated in the ANZCA policy document or to undertake additional monitoring when indicated – for example, use of a pulmonary artery catheter in left ventricular failure.
(iii)	Equipment failure	Death or morbidity as a result of failure to check equipment or due to failure of an item of anaesthesia equipment.
(iv)	Inadequate resuscitation	Failure to provide adequate resuscitation in an emergency situation.
(v)	Hypothermia	Failure to maintain adequate body temperature within recognised limits.

E. Postoperative

(i)	Management	Death or morbidity as a result of inappropriate intervention or omission of active intervention by the anaesthetist or a person under their direction (for example, a recovery or pain management nurse) in some matter related to the patient's anaesthesia, pain management or resuscitation.
(ii)	Supervision	Death or morbidity due to inadequate supervision or monitoring. The anaesthetist has ongoing responsibility, but the surgical role must also be assessed.
(iii)	Inadequate resuscitation	Death or morbidity due to inadequate management of hypovolaemia or hypoxaemia or where there has been a failure to perform proper cardiopulmonary resuscitation.

F. Organisational

(i)	Inadequate supervision, inexperience or assistance	These factors apply whether the anaesthetist is a trainee, a non-specialist or a specialist undertaking an unfamiliar procedure. The criterion of adequacy of supervision of a trainee is based on the ANZCA policy document on supervision of trainees.
(ii)	Poor organisation of the service	Inappropriate delegation, poor rostering and fatigue contributing to a fatality.
(iii)	Failure of interdisciplinary planning	Poor communication in perioperative management and failure to anticipate the need for high dependency care.

G. No correctable factor identifiable

Where the death or morbidity was due to anaesthesia factors but no better technique could be suggested.

H. Medical condition of the patient

Where it is considered that the medical condition was a significant factor in the anaesthesia-related death or morbidity.

Appendix 3: Event categories

Event categories
Airway
Cardiovascular
Drug-related
Equipment-related
Metabolic
Miscellaneous
Neurological
Pain management
Procedure-related
Respiratory

Category: Airway

Abbreviated description of type	Full definition
Airway obstruction	Clinically significant partial or complete upper or lower airway obstruction
Airway soft tissue injury	Injury to non-dental structures
Dental injury	Any injury to the teeth or dental prosthesis
Endobronchial intubation	Unintended clinically significant endobronchial intubation
Failed intubation	Inability to correctly place the endotracheal or endobronchial tube at direct laryngoscopy requiring an alternative technique
Other	Free-text option – clinically significant event that is not otherwise specified

Category: Cardiovascular

Abbreviated description of type	Full definition
Anaemia	Hb < 70 g/L

Category: Equipment-related

Abbreviated description of type	Full definition
Arrhythmia	A clinically significant rate or rhythm disturbance requiring intervention
Cardiac arrest	Cessation of cardiac mechanical activity as confirmed by the absence of signs of circulation
Embolism	Clinically significant suspected air, cement, fat or venous thromboembolism

Abbreviated description of type	Full definition
Haemorrhage	Clinically significant bleeding from any site or source
Hypertension – significant	A 30% or greater increase in systolic BP of at least 5 minutes' duration and requiring intervention
Hypotension – significant	A 30% or greater decrease in systolic BP of at least 5 minutes' duration and requiring intervention
Hypovolaemia	Reduced circulating blood volume leading to significant hypotension
Myocardial ischaemia	Angina and/or characteristic ECG or echocardiographic changes
Myocardial infarction	Confirmed by a rise/fall of cardiac enzymes in the setting of myocardial ischaemia, new Q waves on the ECG, or autopsy findings
Other	Free-text option – clinically significant event that is not otherwise specified

Category: Drug-related

Abbreviated description of type	Full definition
Anaphylaxis	Clinically significant adverse drug reaction consistent with anaphylaxis
Drug error	Inadvertent or inappropriate administration of a drug that may or may not result in harm
Drug-related adverse effect	A clinically significant adverse drug reaction or side effect
Overdose	Clinically significant drug overdose
Other	Free-text option – clinically significant event that is not otherwise specified

Category: Metabolic

Abbreviated description of type	Full definition
Hyperglycaemia	Blood glucose > 10 mmol/L requiring intervention
Hypoglycaemia	Blood glucose < 4 mmol/L requiring intervention
Hypothermia	Unplanned temperature < 35°C on arrival in recovery room or equivalent
Malignant hyperthermia	Clinical evidence or suspicion of malignant hyperthermia
Other	Free-text option – clinically significant event that is not otherwise specified

Category: Miscellaneous

Abbreviated description of type	Full definition
Miscellaneous	Any significant adverse event not suitable for other listed categories
Other	Free-text option - clinically significant event that is not otherwise

Abbreviated description of type	Full definition
	specified

Category: Neurological

Abbreviated description of type	Full definition
Awareness	Postoperative recall of intraoperative events
Delayed emergence	Unintended delay in recovery from anaesthesia
Inadequate neuromuscular block reversal	Clinically significant inadequate reversal of neuromuscular blockade
Nerve/plexus injury	New nerve injury confirmed by neurological examination or investigation
Seizure	Perioperative seizure
Spinal cord injury	New spinal cord injury confirmed by neurological examination or investigation
Stroke (including TIA)	New central nervous system deficit confirmed by investigation or neurological examination
Other	Free-text option – clinically significant event that is not otherwise specified

Category: Pain management

Abbreviated description of type	Full definition
Excessive neuraxial block	Clinically significant and unintended extension of neuraxial analgesia in the postoperative period
Failed regional anaesthesia	Unplanned requirement to give supplemental analgesia for postoperative regional blockade
Inadequate postoperative analgesia	Inadequate postoperative analgesia regardless of chosen modality
Local anaesthetic toxicity	Inadvertent systemic local anaesthetic toxicity related to a postoperative regional technique
Postoperative respiratory depression	Postoperative respiratory depression requiring intervention including naloxone or HDU/ICU care
Other	Free-text option – clinically significant event that is not otherwise specified

Category: Procedure-related

Abbreviated description of type	Full definition
Excessive neuraxial block	Clinically significant and unintended extension of neuraxial anaesthesia or analgesia
Failed regional anaesthesia	Unplanned requirement to give supplemental analgesia or anaesthesia for surgery under local or regional blockade
Inadvertent dural puncture	Unintended dural puncture during epidural insertion
Local anaesthetic toxicity	Inadvertent systemic local anaesthetic toxicity related to regional or local technique

Abbreviated description of type	Full definition
TOE gastro-oesophageal injury	Evidence of gastric or oesophageal injury relating to TOE
Vascular injury	Clinically significant vascular injury resulting from intravascular cannulation
Other	Free-text option – clinically significant event that is not otherwise specified

Category: Respiratory

Abbreviated description of type	Full definition
Aspiration	Clinically significant pulmonary aspiration of gastrointestinal contents, blood or particulate matter with or without radiographic evidence
Bronchospasm	New or increased airflow obstruction, detected by wheeze +/or increased inspiratory pressures during mechanical ventilation
Hypoventilation	Clinically significant inadequate minute ventilation
Нурохіа	SpO ₂ < 90% for > 5 minutes or < 80% for > 2 minutes
Pneumothorax	Clinical or radiological evidence of gas in pleural space
Pulmonary oedema	Presence of pink frothy fluid in airway or radiological evidence
Respiratory arrest	Prolonged apnoea requiring urgent intervention
Unplanned postoperative ventilation	Invasive or non-invasive postoperative ventilation not planned prior to induction of anaesthesia
Other	Free-text option – clinically significant event that is not otherwise specified

Event outcomes

Abbreviated description of outcome	Full definition
Uneventful (critical incident)	No patient harm
Minor adverse event (minor morbidity)	Mild or transient injury to the patient
Major adverse event (major morbidity)	Severe life-threatening event, permanent disability or prolongation of hospital stay including unplanned ICU admission
Death (mortality)	Death

Appendix 4: Preventability score

Abbreviated description of preventability (score)	Full definition
Not preventable (0)	No reasonable evidence of preventability (likelihood < 10%)
Possibly preventable (1)	Modest evidence of preventability (likelihood 10-50%)
Probably preventable (2)	More than likely to have been preventable (likelihood 51–90%)
Definitely preventable (3)	Strong evidence of preventability (likelihood > 90%)

Appendix 5: Council functions

The Victorian Consultative Council on Anaesthetic Mortality and Morbidity was established in 1976 under s. 13 of the *Health Act 1958*. The council now operates pursuant to ss. 33–43 of the *Public Health and Wellbeing Act 2008*.

Terms of reference

The role of the council is to provide advice to the Minister for Health and the Department of Health and Human Services on avoidable causes of morbidity and mortality relating to anaesthesia.

The council works closely with the Department of Health and Human Services in its role to advise on strategies to reduce avoidable anaesthesia-related mortality and morbidity.

The Clinical Councils Unit within the Health Service Programs Branch, Health Service Performance and Programs Division, Department of Health and Human Services manages and supports the work programs of the council and two other consultative councils.

Functions of the VCCAMM

The functions of the council as outlined in the Public Health and Wellbeing Act are to:

- a) monitor, analyse and report on matters specified for that prescribed consultative council, which for this council relates to potentially preventable anaesthetic mortality and morbidity within the Victorian hospital system
- b) collect information for the purpose of performing the functions specified in this subsection
- c) keep a register of anaesthetic mortality and morbidity within the Victorian hospital system
- d) publish an annual report on the activities of the prescribed consultative council
- e) improve public health and wellbeing by publishing and disseminating relevant information and practical strategies identified by the prescribed consultative council of performing its functions
- f) consider, investigate and report on any matter specified by the Minister or Secretary in the direction of the council or the prescribed secretary in a direction to the prescribed consultative council
- g) liaise with any other consultative council on any matter relevant to the functions of the prescribed consultative council
- h) perform any function specified in the order which established that prescribed consultative council
- i) perform any other prescribed function.

Appendix 6: Council membership 2012–2014

Member	Position
A/Prof. Larry McNicol (Chair)	Director, Department of Anaesthesia, Austin Health
Dr Alexander Babarczy	Specialist Anaesthetist
Dr Christopher Bain	Specialist Staff Anaesthetist, Alfred Health
Dr Robert Beavis	Specialist Anaesthetist
Dr David Beilby	Director of Anaesthesia, Eastern Health
Dr Heinreich Bouwer	Pathologist, Victorian Institute of Forensic Medicine
Dr Jennifer Carden	Specialist Anaesthetist
Dr David Charlesworth	Director, Intensive Care Unit, Eastern Health
Dr Robert Dawson	Visiting Medical Officer, Latrobe Regional Hospital/Maryvale Hospital
Dr Paul Francis	Rural Visiting Medical Officer
Dr Michael Dobson	Specialist ENT surgeon, Royal Victorian Eye and Ear Hospital
Dr Gaylene Heard	Specialist Anaesthetist, St Vincent's Hospital Melbourne
A/Prof Terence Loughnan	Director of Anaesthetic Research and Training, Peninsula Health, Frankston
Dr Patricia Mackay	Emeritus Consultant, VCCAMM
Dr John Monagle	Director of Anaesthesia, Monash Medical Centre
Dr Philip Ragg	Deputy Director of the Department of Anaesthesia and Pain Management, The Royal Children's Hospital
A/Prof. Bernhard Riedel	Director of Anaesthesia, Department of Cancer Surgery, Peter McCallum Cancer Centre
Dr Andrew Ross	Senior Anaesthetist, Mercy Hospital for Women
Dr Simon Tomlinson	Director of Anaesthesia, Peri-Operative Medicine and Pain Management, Barwon Health
Dr Gino Toncich	Specialist in Emergency Medicine, The Royal Melbourne Hospital
Dr Maggie Wong	Specialist Anaesthetist, Visiting Medical Officer, St Vincent's Hospital Melbourne and The Royal Women's Hospital

Appendix 7: Current council membership

Member	Position
Associate Professor Larry McNicol (Chair)	Director, Department of Anaesthesia, Austin Health
Dr Andrea Kattula (Deputy Chair)	Leader, Clinical Practice Improvement, Alfred Health
Dr Christopher Bain	Specialist Cardiothoracic Anaesthetist, Department of Anaesthesia and Perioperative Medicine, Alfred Health
Dr David Beilby	Deputy Director of Anaesthesia, Eastern Health
Dr Heinrich Bouwer	Consultant Forensic Pathologist, Victorian Institute of Forensic Medicine
Dr Robert Dawson	Staff Anaesthetist, Latrobe Regional Hospital
Ms Sharon Donovan	Executive Director Clinical Services, Epworth Healthcare
Ms Katy Fielding	Manager, Acute Programs, Department of Health and Human Services
Ms Paula Foran	Clinical Facilitator, Perioperative Education, South West Healthcare
Dr Andrew Jeffreys	Clinical Services Director, Division of Perioperative and Critical Care Services, Western Health
Ms Annette McPherson	Consumer representative
Ms Viktoria Rother	Consumer representative
Dr Simon Tomlinson	Director, Anaesthesia, Peri-operative and Pain Medicine, Barwon Health
Dr Margaret Way	Director, Quality and Risk and Clinical Governance, Alfred Health
Dr Maggie Wong	Sessional Anaesthetist, Supervisor of Anaesthesia Training, Department of Anaesthesia, The Royal Women's Hospital

Appendix 8: Current Case Review Subcommittee membership

Member	Position
Dr Andrea Kattula (Chair)	Leader, Clinical Practice Improvement, Alfred Health
Dr Simon Tomlinson (Deputy Chair)	Director, Anaesthesia, Peri-operative and Pain Medicine, Barwon Health
Dr Chris Bain	Specialist Cardiothoracic Anaesthetist, Department of Anaesthesia and Perioperative Medicine, Alfred Health
Dr David Beilby	Deputy Director of Anaesthesia, Eastern Health
Dr Heinrich Bouwer	Consultant Forensic Pathologist, Victorian Institute of Forensic Medicine
Dr Robert Dawson	Staff Anaesthetist, Latrobe Regional Hospital
Dr Michael Dobson	Visiting Surgeon, Epworth Eastern Hospital, Royal Victorian Eye and Ear Hospital, Box Hill Public Hospital, St Vincent's Private Hospital
Dr Paula Foran	Education Officer, Australian College of Operating Room Nurses
Dr Gaylene Heard	Senior Anaesthetist, St Vincent's Hospital, Western Health, Royal Victorian Eye and Ear Hospital, Dental Health Services Victoria
Dr Andrew Jeffreys	Clinical Services Director, Division of Perioperative and Critical Care Services, Western Health
A/Prof. Philip Ragg	Staff Consultant Anaesthetist, Co-Deputy Director, Chief Coordinator, Cardiac Anaesthesia and Acute Pain Management Service Consultant, The Royal Children's Hospital
Ms Viktoria Rother	Patient advocate, postgraduate student, freelance EAL teacher
Dr Maggie Wong	Sessional Anaesthetist, Supervisor of Anaesthesia Training, Department of Anaesthesia, The Royal Women's Hospital

References

- [1] Special Committee Investigating Deaths Under Anaesthesia. SCIDUA, Clinical Excellence Commission, 2017. Online. Available at: www.cec.health.nsw.gov.au/incidentmanagement/mortality-review-committees/scidua
- [2] National Health and Medical Research Council. Report on anaesthetic related mortality in Australia 1985–1987, Canberra. 1990.
- [3] McNicol L (ed.). Safety of anaesthesia in Australia and New Zealand 2009–2011. Australian and New Zealand College of Anaesthetists, Melbourne. 2014.
- [4] Victorian Audit of Surgical Mortality, Online. Available at: www.surgeons.org/vasm
- [5] Duckett S. Review of hospital safety and quality assurance in Victoria. Department of Health and Human Services, Melbourne. 2015. Online. Available at: www2.health.vic.gov.au/hospitals-andhealth-services/quality-safety-service/hospital-safety-and-quality-review
- [6] Better, Safer Care 2017, Better, Safer Care. Online. Available at: www2.health.vic.gov.au/hospitalsand-health-services/quality-safety-service/better-safer-care
- [7] Crilly H, Rose, M. Anaphylaxis and anaesthesia can treating a cough kill ? Aust Prescr 2014; 37: 74-76
- [8] MacAleer, P, McNicol L, Rose. Perioperative anaphylaxis: progress, prevention and pholcodine policy. Anaesth Intensive Care 2017; 45(2): 147-50.
- [9] de Pater G, Florvaag E, Johansson SGO, Irgens A, Petersen M, Guttormsen AB. Six years without pholcodine; Norwegians are significantly less IgE sensitized and clinically more tolerant to neuromuscular blocking agents. Allergy 2017. DOI:10.1111/all.13081
- [10] Katelaris C, Kurosawa M, Moon H, Borres M, Florvaag E, Johansson S. Pholcodine consumption and immunoglobulin E-sensitization in atopics from Australia, Korea and Japan. Asia Pac Allergy 2014; 4: 86-90
- [11] Australian Institute of Health and Welfare. Online. Available at: www.aihw.gov.au
- [12] Weinstein M, Torrance G, McGuire A. QALYS: The basics. Value in health, volume 12, supplement 1, 2009 International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 1098 – 3015/09/SS S5-S9
- [13] Story D, Leslie K, Myles P, Fink M, Poustie S, Forbes A, Yap S, Beavis V, Kerridge R. Complications and mortality in older surgical patients in Australia and New Zealand (the REASON study): a multicentre, prospective, observational study. Anaesthesia 2010; 65: 1022-30
- [14] Shulman M, Myles PS, Chan MT, McIlroy DR, Wallace S, Ponsford J. Measurement of disability free survival after surgery. Anesthesiology 2015; 122: 524-36
- [15] Hubbard RE, Story DA. Patient frailty: the elephant in the operating room. Anaesthesia 2014; 69 (Suppl 1): 26-34
- [16] Soreide K, Story DA, Walder B. Perioperative medicine and mortality after elective and emergency surgery. Eur J Anaesthesiol 2016; 33(5): 314-16
- [17] Soreide K, Desserud KF. Emergency surgery in the elderly: the balance between function, frailty, fatality and futility. Scand J Trauma Resusc Emerg Med 2015; 23: 10
- [18] Hewitt J, Moug SJ, Middleton M, Chakrabarti M, Stechman MJ, McCarthy K. Prevalence of frailty and its association with mortality in general surgery. Am J Surg 2015; 209: 254-59

- [19] ASA Physical Status Classification System Online. Available at: www.asahq.org/clinical/physicalstatus.htm
- [20] Frerk C, Mitchell VS, McNarry AF, Mendonca C, Bhagrath R, Patel A6, O'Sullivan EP, Woodall NM, Ahmad I. Difficult airway society 2015 guidelines for management of the unanticipated difficult intubation in adults. Br J Anaesth 2015; 115(6): 827-48
- [21] Law JA, Broemling N, Cooper RM, et al. The difficult airway with recommendations for management part 1 - difficult tracheal intubation encountered in an unconscious/induced patient. Can J Anaesth 2013; 60(11): 1089-118
- [22] Heard AM, Green RJ, Eakins P. The formulation and introduction of a 'can't intubate, can't ventilate' algorithm into clinical practice. Anaesthesia 2009; 64(6): 601-08
- [23] Heard AM, Percutaneous emergency oxygenation in the 'can't intubate, can't oxygenate' scenario, in the definitive guide for anaesthetists. 2013. Online. Available at: www.smashwords.com/books/view/377530
- [24] Australian and New Zealand College of Anaesthetists. Guidelines for the management of evolving airway obstruction: transition to the 'can't intubate, can't oxygenate' airway emergency. Online. Available at: www.anzca.edu.au/getattachments/resources/professional.documents/ps61_guidelines_cognitive_ aid_2016.pdf
- [25] Australian and New Zealand College of Anaesthetists, CICO and front of next access. Online. Available at: www.anzca.edu.au/front.page.news/CICO-and-front-of-neck-access
- [26] The Vortex Approach. Online. Available at: vortexapproach.org
- [27] Kolawale H, Marshall SD, Crilly H, Kerridge R, Roessler P. Australian and New Zealand Anaesthesia Allergy Group/ANZCA Perioperative anaphylaxis management guidelines. Anaesth Intens Care 2017; 45(2): 151-58
- [28] Australian and New Zealand College of Anaesthetists. Guidelines for the safe administration of injectable drugs in anaesthesia. Online. Available at: www.anzca.edu.au/documents/ps51-2009-guidelines-for-the-safe-administration-of-injectable- drugs-in-anaesthesia.pdf
- [29] Australian Commission on Safety and Quality in Health Care. User applied labelling of injectable medicines, fluids and lines. Online. Available at: www.safetyandquality.gov.au/wpcontent/uploads/2015/09/National-Standard-for-User-Applied-Labelling-Aug-2015.pdf
- [30] The Victorian Quality Council. Acute pain management measurement toolkit. Department of Human Services, Melbourne. 2007.
- [31] Court Administration Authority, Coroners Findings, Finding of Inquest John Williams Ryan and Patricia Dawn Walton. Online. Available at: http://www.courts.sa.gov.au/CoronersFindings/Lists/Coroners%20Findings/Attachments/581/RYA N%20John%20William%20and%20WALTON%20Patricia%20Dawn.pdf
- [32] Hollis RH, Graham LA, Lazenby JP, Brown DM, Taylor BB, Heslin MJ, Rue LW, Hawn MT. A role for the early warning score in early identification of critical postoperative complications. Ann Surg 2016; 263(5): 918-23
- [33] Ho L, Spanger M, Hayward P, McNicol L, Weinberg L. Missed carotid artery cannulation: a line crossed and lessons learnt. Anaesth Intens Care 2014; 42(6): 793-800
- [34] Goulding G. Unrecognised carotid arterial cannulation: prevention and management. Anaesth Intens Care 2014; 42(6): 696-99

- [35] Piercy M, McNicol L, Dinh DT, Story DA, Smith JA. Major complications related to the use of transoesophageal echocardiography in cardiac surgery. J Cardiothorac Vasc Anesth 2009; 23: 62-65
- [36] Australian and New Zealand College of Anaesthetists, WHO surgical safety checklist. Online. Available at: www.anzca.edu.au/documents/who-surgical-safety-checklist
- [37] Australian and New Zealand College of Anaesthetists, Stop, Block poster. Online. Available at: www.anzca.edu.au/documents/stop-blocking-poster-campaign-a3-p1-hr