Activities of the Special Committee Investigating Deaths Under Anaesthesia

Annual Report 2021

NSW GOVERNMENT

CLINICAL EXCELLENCE COMMISSION

DISCLAIMER

All identifying information has been omitted to preserve anonymity.

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CLINICAL EXCELLENCE COMMISSION

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Executive Summary

The Special Committee Investigating Deaths Under Anaesthesia (SCIDUA) has been reviewing deaths since 1960. Because sedation and anaesthesia exist on a continuum of a decreased level of consciousness and use the same, or similar, drugs, the committee also reviews sedation-related deaths in New South Wales. For the purposes of this report, no distinction is made between anaesthesia-related and sedation-related deaths.

In New South Wales, it is mandatory, under section 84 of the *Public Health Act 2010,* for public and private facilities to report to SCIDUA any death arising after anaesthesia or sedation is administered.

Activity for the committee in 2021 included 306 notified deaths, where death had occurred during, due to, or within 24 hours of, an anaesthetic or administration of sedative drugs for medical/surgical procedures. Of these, 246 deaths fell within the criteria of the terms of reference, and 56 cases were classified by the committee as being, wholly or partly, related to anaesthetic factors, as follows:

- 16 cases where anaesthesia either directly caused, or substantially contributed to, the patient's death (Category 1 and 2)
- 40 cases where a combination of anaesthesia and surgical factors contributed to the patient's death (Category 3)

Further analysis of the data for anaesthesia-related deaths identified that:

- Most patients (87.5%) were 63 years or older, with the lowest adult age being 41.
- More than half (53.57%) were classified as critically ill and assessed as an ASA 4.
- The median age of male patients is 75 years and female 84 years.
- 29 deaths (51.79%) were for patients undergoing an orthopaedic procedure.
- 16 deaths (28.57%) occurred in the operating theatre or procedural room.
- 7 deaths (12.5%) under sedation were for patients aged between 70 and 89 years.

The committee reviews the anaesthesia-related deaths to identify any management choices it considers could be improved upon; these are called *correctable factors*. In 2021, the committee determined that 73.21% (n=41) of deaths had *no correctable factor*.

Data shows that for the 15 anaesthesia-related deaths with correctable factors:

- 24 issues across 10 causal factor categories were determined to be present.
- Causal or contributing factors for 9 deaths (60%) was *anaesthetic technique*; with airway maintenance (8), and ventilator-related factor (1).
- Causal or contributing factors for 6 deaths (40%) was pre-operative assessment, with a further two deaths identifying *post-operative management* factors.
- 11 deaths (73.33%) were for patients aged 65 years or above.

Australia remains one of the safest places in the world to undergo a surgical procedure.

- Estimated resident population in New South Wales, reported by the Australian Bureau of Statistics as at 31 December 2021, was 8,095,400.
- Admitted Patient Data Collection[1] to examine the number of episodes of anaesthesia administered to patients in 2021, identified 700,609 episode end dates, i.e., Public 303,311; Private: 396,298.
- Patient deaths/separations, (n=2,085 deaths, i.e., Public: 1,835; Private: 250).
- Number of 2021 deaths notified to SCIDUA (n=265).
- Number of classified anaesthesia-related deaths (n=50; Category 1-3 deaths).
    - Anaesthesia as a contributing factor to death (n=39)
    - Anaesthesia as the direct cause of death (n=11)

Risk calculations for 2021 deaths under anaesthesia determined that the chance of:

- any patient *dying while undergoing a procedure* was 1:2,643 (0.03%)
- anaesthesia *contributing to the death* 1:14,012 (0.007%)
- anaesthesia *directly causing death* being 1:63,691 (0.002%).

[1] **Source:** Admitted Patient, Emergency Department Attendance and Deaths Register, NSW Ministry of Health SAPHaRI, data extracted on 12-02-2024.

Members of the committee

Dr Carl D'Souza
Chairperson

BSc MBBS FANZCA

Dr David McLeod
Member

MBBS FANZCA PGDip ECHO

Dr Damien Boyd
Member

MBBS FANZCA

Dr Benjamin Olesnicky
Member

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Dr Jonathan Gibson
Member

MBBS FANZCA

Dr Angela Suen
Member

MBBS BMedSc MClinMed FANZCA

Dr Sarah Johnston
Member

MBBS FANZCA

Dr David Elliott
Member

MBBS FANZCA

Retiring members of the committee

Special thanks is expressed to Fran and Liz for their commitment to the objectives of the Committee and for their dedication to excellence throughout their careers.

Dr Frances Smith

MBBS FRACP FANZCA FCICM

Dr Smith has extensive clinical anaesthetic management experience in various facilities across NSW and had several deployments with the Australian Army (2004-2009).

She has published many scholarly articles and presented at several seminars and conferences. Her membership extends for more than 20 years.

Dr Elizabeth O'Hare

MBBS FFARACS FANZCA

Dr Elizabeth O'Hare has been actively involved in quality assurance and morbidity and mortality for three decades in multi-disciplinary settings and is a Visiting Medical Officer in both public and private practice. Her membership extends for more than 10 years.

The **Clinical Excellence Commission** would like to extend its gratitude to long-serving members of SCIDUA, Drs Smith and O'Hare. Their dedication towards ensuring safe and effective practices occur for anaesthesia administration is commendable.

Chairperson's foreword

If I could choose to undergo a procedure anywhere in the world, I would choose New South Wales. I would do this with the knowledge that the anaesthetic services provided by practitioners in NSW is considered amongst the safest in the world. I would do this with the knowledge that anaesthetists providing anaesthetic services have had an outstanding education, exceptional training and the necessary experience to handle anything that is thrown at them.

This report highlights the ongoing wonderful safety record of anaesthesia in NSW and is due entirely to the anaesthetists who are in practice today.

Despite being a robust system, there are times where outcomes are not as one would expect. The cases and reflection points included in this report help flag some of the factors where things could have been done differently and perhaps change the outcome. Please read them and discuss the cases with your colleagues. It is by sharing information and our ideas that we become better at what we do.

Some of these cases also highlight the emerging theme of non-beneficial surgery. Elderly, frail, or those with end-of-life illnesses require careful consideration before embarking on surgery. This reinforces the concepts in the recent SCIDUA publication – Just because we can, it doesn't mean we should.

The cases also highlight the concepts of invasive monitoring and fluid resuscitation prior to induction, appropriate dosing of induction agents, being mindful of the synergistic effects of induction agents leading to hypotension, and the use of anticipatory vasopressors.

As in every year, I am extremely grateful to the anaesthetists and family members who have given their permission to use these cases so that others may learn.

This educational report is only possible because of the practitioners in NSW being conscientious about reporting their cases to SCIDUA. While it may be just another form to fill out at an already stressful time, it will save life in the future. So, thank you for doing this.

I hope you share this report with as many colleagues as you can and have many conversations as a result.

Dr Carl D'Souza

SCIDUA Chairperson

Special Committee Investigating Deaths Under Anaesthesia

Ministerial committee

The NSW Special Committee Investigating Deaths Under Anaesthesia is an expert committee established by the Minister for Health and has been in operation since 1960. Its current terms of reference are:

> *'to subject all deaths which occur while under, as a result of, or within 24 hours after, the administration of anaesthesia or sedation for procedures of a medical, surgical, dental or investigative nature to peer review so as to identify any area of clinical management where alternative methods could have led to a more favourable result'.*

The Minister for Health appoints members to the committee for a term of five years. The committee elects its own Chairperson, who must be a currently practising anaesthetist.

The committee has anaesthetists from a broad range of clinical specialties and professional organisations. Nominations for membership are invited from the Australian and New Zealand College of Anaesthetists (ANZCA), the Australian Society of Anaesthetists and academic departments of anaesthesia.

Why is this important?

Anaesthesia is not a medical therapy in itself but is performed so that a medical or surgical procedure can be performed. Ideally, there would be no adverse outcomes from the anaesthetic. Unfortunately, all current anaesthetic and sedative drugs are either cardiovascular and/or respiratory depressants and their administration is subject to human error. Additionally, the specialised equipment and monitors that are used may be subject to faults and/or incorrect use.

Anaesthetists monitor, interpret and react to changes in the patient's condition. These changes could be due to the underlying disease process, the patient's intercurrent diseases, interactions or reactions to drugs, or due to the surgical/medical procedure taking place and its complications.

It is important to look for emerging trends because anaesthetic, surgical and medical interventions change with time. It is also important to monitor anaesthetic outcomes and look for ways to reduce any adverse events.

We would like to see the notification of death submitted to SCIDUA as soon as possible after the event - while it is still fresh in the practitioner's mind. This is when small details are retained, which can aid in the analysis of an unfortunate patient outcome.

Legislation

The committee is afforded special privilege under section 23 of the *Health Administration Act 1982*. This legislation makes it an offence for a person who obtains information in connection with the work of the committee to disclose the information without obtaining the proper authorisation. In doing so, it is vital to preserve anonymity.

> *Confidentiality of all communications between the reporting anaesthetist and the committee is paramount. Information can only be released with the consent of the person who provided the information, or the approval of the NSW Minister for Health, or authorised delegate.*

Permission was sought from each practitioner to share their cases in this report to assist in the prevention of future deaths under anaesthesia. SCIDUA would like to extend its gratitude to those generous practitioners.

Notifications

The notification of a death arising after anaesthesia or sedation for operations or procedures is a mandatory requirement in New South Wales, regardless of whether the death proceeded for Coronial investigation. Public Health Organisations use the Death Review Database to assist them to identify deaths that meet the criteria requirements for SCIDUA.

Reporting to SCIDUA is required under section 84 of the *Public Health Act 2010* and applies:

> *'if a patient or former patient dies while under, or as a result of, or within 24 hours after, the administration of an anaesthetic or a sedative drug administered in the course of a medical, surgical or dental operation or procedure or other health operation or procedure (other than a local anaesthetic or sedative drug administered solely for the purpose of facilitating a procedure for resuscitation from apparent or impending death).'*

Some medical practitioners may be under the false impression that deaths which occur greater than 24 hours after administration of an anaesthesia are not reportable. This is not the case. If an intra-operative event occurs resulting in a patient's death, that death is reportable, even if it occurs days or weeks later.

Health practitioners are required to notify the death by emailing a completed report form to: CEC-SCIDUA@health.nsw.gov.au.

With the recent increase in non-invasive procedures being undertaken by both physicians and radiologists, we have clarified the need for reporting of these cases. If local anaesthetic alone was administered to enable the procedure to be undertaken, there is no need to report this death to SCIDUA. If, however, any sedative agent was concurrently used, then this is considered a reportable death.

Cases may also be referred to SCIDUA by the CEC's Patient Safety Team and the Collaborating Hospitals' Audit of Surgical Mortality (CHASM) Program if there is concern that anaesthesia may have been a factor in a patient's death.

Process

All reported deaths are reviewed by the triage sub-committee which can either classify the death as due to factors not falling under the control of the health practitioner, or request further information from the reporting health practitioner, via a SCIDUA questionnaire, for the committee to further discuss the case and its classification.

The questionnaire is always sent if there is any suspicion that the anaesthetic or sedation was involved, or if the patient died during the procedure or in the recovery period. A questionnaire is also sent when there is a paucity of information on the initial notification form. The medical practitioner may wish to make further confidential information available to the committee that was not available in the patient's medical record.

When questionnaires are returned, all information is de-identified and distributed to members of the committee prior to its meetings for review. Cases are discussed at each meeting and classified. A confidential reply by the Chairperson is sent to the health practitioner explaining the committee's decision.

The committee manages its data in a secure Microsoft SQL server relational database. It stores data on patients and anaesthetists, as well as information collected from the notification form, questionnaire and triage sub-committee and committee meetings. The CEC is responsible for data management, ensuring accurate reporting, interpretation and verification of anaesthesia-related deaths.

System of classification

SCIDUA deaths are classified using a system agreed upon by the ANZCA Anaesthesia Mortality Sub-committee in 2006, revised in 2020. Categories are ordered into three main groups, as below.

Group A contains deaths where anaesthetic factors are thought to have played a role. The intention of the classification is not to apportion blame on individual cases, but to establish the contribution of the anaesthesia factors to the death. There are three categories:

Category 1	Where it is reasonably certain that death was caused by the anaesthesia or other factors under the control of the anaesthetist
Category 2	Where there is some doubt whether death was entirely attributable to the anaesthesia, or other factors under the control of the anaesthetist
Category 3	Where both surgical and anaesthetic factors were thought to have attributed to the death
Note: The above classification is applied regardless of the patient's condition before the procedure. However, if it is considered that the medical condition makes a substantial contribution to the anaesthesia-related death, subcategory **H** should also be applied. If no factor under the control of the anaesthetist is identified which could or should have been done better, subcategory **G** should also be applied.	

Group B has three categories of death where anaesthesia is thought to have played no part:

Category 4	Surgical death where the administration of the anaesthesia is not contributory and surgical or other factors are implicated
Category 5	Inevitable death (with or without surgery), which would have occurred irrespective of anaesthesia or surgical procedure
Category 6	Incidental death, which could not reasonably be expected to have been foreseen by those looking after the patient, was not related to the indication for surgery and was not due to factors under the control of anaesthetist or surgeon

Group C identifies deaths where the factors involved in the patient's death are not fully assessable. There are two categories:

Category 7	Those that cannot be assessed, despite considerable data, but where the information is conflicting or key data is missing. The committee uses this category when it is unable to find out the actual cause of death
Category 8	For cases which cannot be assessed as the available data is inadequate to make a final determination

Underpinning the case classification for Group A deaths are sub-categories for a causal or contributory factors. There is often more than one factor to be identified in anaesthesia-related deaths.

The committee understands that this classification system has its limitations; however, it is a universal system used by all states of Australia. There are some instances when the patient's disease or condition is the main contributing factor to the patient's death, particularly as proceduralists now operate on older, sicker patients.

On occasion surgical intervention may be the precipitating factor that leads to the death, but it is often difficult to dissociate the effects of the anaesthetic and the anaesthetist's response to the critical incident, as contributing factors.

In these situations, cases are often classified as Category 3GH (the anaesthetic, surgery and significantly the patient's own serious medical condition, were factors that contributed to the death), yet the committee was satisfied with the anaesthetic and surgical management.

Communication and Reporting

SCIDUA communicates with its key stakeholders in the following manner:

- Each individual anaesthetist who provides information to the committee receives a letter from the Chairperson explaining the reasons behind the committee's views on their case
- A report for the preceding calendar year is provided to the Minister for Health

The ANZCA Mortality Sub-committee report into the "Safety of Anaesthesia in Australia" now reports urgency, based on whether the patient was admitted for scheduled (elective) surgery or as an emergency admission.

The Chairperson and members provide presentations at various forums throughout the year. This encourages candid conversations concerning clinical management and communication that enables SCIDUA to consider these points of view with a patient safety focus.

In addition, the committee periodically submits reports to peer-reviewed journals, in which trends in anaesthesia-related mortality are described. These reach a wide range of anaesthetists in Australia, New Zealand and internationally.

Committee Activity in 2021

The committee met 5 times in 2021 and, together with the triage sub-committee who met 9 times in 2021, reviewed 353 deaths. Classification was finalised at triage for 242 deaths, with 56 deaths classified by the full committee. Of the 306 deaths classified in 2021, 182 (58.48%) occurred in 2021 and 120 (39.22%) in 2020.

Not all deaths reviewed occurred in the reporting year. There are varying reasons for this, including delay to notification, delayed response from the clinician, and review carried over from the previous year (of which there were 18).

Further, not all deaths notified to SCIDUA meet the criteria outlined in the terms of reference, particularly if it is considered that anaesthesia or sedation was not thought to be implicated in any way. In 2021, 4 deaths were excluded from further investigation.

We remind all medical practitioners that once an anaesthetic or sedation drug is given (regardless of the amount given) that patient is deemed to have had a procedure under anaesthesia / sedation and should a death occur, that death is reportable.

Of the Group A deaths reviewed and classified by the committee, 19 are included in this publication as case examples. The following graphs and tables breakdown the elements of these anaesthesia-related deaths and causal factors.

Table 1 below depicts the breakdown of classified deaths by group and category.

Death Type	Category	No. of cases
Group A: Deaths attributable to anaesthesia	1 - Where it is reasonably certain that death was caused by the anaesthesia or other factors under the control of the anaesthetist	7
	2 - Where there is some doubt whether death was entirely attributable to the anaesthesia or other factors under the control of the anaesthetist	9
	3 - Where death was caused by both surgical and anaesthesia factors	40
Sub Total		**56**
Group B: Deaths in which anaesthesia played no part	4 - Death where the administration of the anaesthesia is not contributory and surgical or other factors are implicated	18
	5 - Inevitable death, which would have occurred irrespective of anaesthesia or surgical procedures	215
	6 - Incidental death which could not reasonably be expected to have been foreseen by those looking after the patient, was not related to the indication for surgery and was not due to factors under the control of the anaesthetist or surgeon	6
Sub Total		**239**
Group C: Un-assessable deaths	7 - Those that cannot be assessed despite considerable data but where the information is conflicting or key data are missing	2
	8 - Cases that cannot be assessed because of inadequate data.	5
Sub Total		**7**
Excluded		4
Grand Total		**306**

Table 1: Distribution of classified deaths by category.

Category 1 Deaths

These deaths are classified as: Where it is reasonably certain that death was caused by the anaesthesia or other factors under control of the anaesthetist.

CASE 1

Summary

A patient in their late seventies had a laser prostatectomy. They had a known allergy to cephazolin (anaphylaxis).

Background Medical History

The background history was considerable and included ischaemic heart disease, previous cerebral vascular accident, peripheral vascular disease with an abdominal aortic aneurysm repair. The patient was reviewed by a cardiologist pre-operatively.

Anaesthetic Details

A spinal anaesthetic was administered with 2.6mls of heavy bupivacaine, with fentanyl and morphine.

Events

After administering the spinal anaesthetic, the patient was positioned and given antibiotic cover. The patient started to cough and felt unwell. Immediately the anaesthetist had recognized that cephazolin was administered inadvertently. The patient then became wheezy and their blood pressure fell.

Dexamethasone and then adrenaline 100microg was given. A cardiac arrest (asystole) ensued. The patient was intubated and resuscitation commenced. Adrenaline 18mg was given over that time along with fluids and sodium bicarbonate. Resuscitation was ceased an hour later.

Reflection Points from the Committee

- Drug errors occur in Anaesthesia.
- Having systems in place to avoid these is helpful:
    - Having information about the patient and their allergies well before the operation allows time for information to be processed, rather than acquiring all of this information in the anaesthetic bay prior to surgery.
    - Take care with drawing up medications for a subsequent patient without knowing their history/allergies.
    - Performing Time Out procedures in accordance with NSW Health policy.
- Anaphylaxis can be fatal even with immediate recognition and management.
- Having a spinal anaesthetic on board makes resuscitation very difficult.

CASE 2

Summary

A patient in their mid-sixties presented to hospital with a contained rupture of diverticulum. They were treated conservatively for five days but had deteriorated and required a Hartmann's procedure. There was no nasogastric tube in place.

Background Medical History

The patient's BMI was 35, but they were in prior good health. On examination they had a Mallampati Grade 4 score. A rapid sequence induction was planned with a video laryngoscope.

Anaesthetic Details

Alfentanil 1mg, fentanyl 100microg, ketamine 100mg and propofol TCI Target 4microg/ml was used for induction. Rocuronium 100mg used for paralysis.

Immediately post induction, black fluid filled the oropharynx. Cricoid pressure was applied (which immediately controlled the reflux) along with suction. The patient was intubated over a bougie. The tracheal tree was suctioned.

High airway pressures were noted post-intubation (35cms H_2O to achieve a tidal volume of 450mls). Oxygen saturation was 95% on 100% oxygen.

Events

The case commenced. During the case the patient became harder to ventilate and oxygenate (saturations of 80% despite 100% oxygen). Noradrenaline was now also required. The case was completed, and the patient taken to ICU.

A chest x-ray confirmed aspiration pneumonitis with no pneumothorax. A referral for extracorporeal membrane oxygenation was made to a tertiary centre, but the family decided upon palliation.

Reflection Points from the Committee

- Consideration should be given for management/resuscitation in a high dependency environment prior to surgery to facilitate optimization of sick patients.
- A Nasogastric tube should have been used on the ward as part of the management. No one likes putting them down nor having one, but they can be life-saving.
- Rapid sequence inductions with cricoid pressure applied immediately upon loss of consciousness is advised.
- In elderly, frail or sick individuals try and keep inductions simple. Multiple drugs lead to increased induction time and more chance for error.

CASE 3

Summary

A patient in their early eighties presented with a large bowel obstruction (transverse colon mass). They were in a poor condition preoperatively with oxygen saturations of 94%.

Background Medical History

Their history included chronic airflow limitation, type 2 diabetes mellitus and peripheral vascular disease, including a known abdominal aortic aneurysm.

Anaesthetic Details

The patient was induced with fentanyl 100microg, propofol 100mg and suxamethonium 100mg, and cricoid pressure applied. On insertion of the laryngoscope the oropharynx was filled with faecal material. This was suctioned and the patient was intubated using a video laryngoscope. No CO_2 trace was obtained. The endotracheal tube position was checked with the video laryngoscope, which confirmed correct placement. A cardiac arrest was called.

Events

The endotracheal tube was suctioned and copious amounts of faecal matter was removed. An end-tidal CO_2 ($ETCO_2$) trace returned and oxygen saturations improved from 50% to 90%. The patient was stabilized; an arterial line was inserted and the surgery commenced after a team discussion.

The case was completed and the patient transferred to ICU. Noradrenaline, adrenaline and vasopressin were commenced. Over the next few hours, the patient's condition continued to deteriorate and a decision was made to palliate them.

Reflection Points from the Committee

- If there is no CO_2 trace post-intubation, it is imperative to confirm correct placement of an endotracheal tube. If removing and reinserting a tube is not feasible, nor visualization with a video-laryngoscope (given the high degree of airway soiling), inserting a bronchoscope to visualize tracheal rings removes all doubt and then focusing on other causes can begin.
- Any patient with a bowel obstruction should be treated as a high aspiration risk – and accordingly requires a nasogastric tube on the ward and a rapid sequence induction with cricoid pressure in theatre. Even if these are done aspiration can still occur.
- Arterial line insertion is recommended preoperatively in sick/frail patients or those having major surgical procedures. This allows rapid assessment and recognition of haemodynamic instability, volume status, respiratory function and response to resuscitative efforts.

CASE 4

Summary

A patient in their early seventies presented for a paravertebral block for cancer related pain management.

Background Medical History

They suffered from recurrent metastatic gastric cancer (previous Ivor Lewis) and were under palliative care awaiting a coeliac plexus block.

Anaesthetic Details

The patient was positioned laterally and sedated with propofol TCI at 0.2microg/ml. The block was technically difficult due to ultrasound anatomy not being straight forward. The catheter was eventually placed (negative aspiration test) and then ropivacaine 0.2% (20mls + 10mls) given. The patient was transferred to recovery awake.

Events

Five minutes later the patient had severe hypotension with blood pressure 49/18mmHg and became unresponsive. This was treated with bag mask ventilation, fluids, metaraminol and atropine. A lung ultrasound showed no pneumothorax. Given the patient had an advanced care directive, no escalation in resuscitation was attempted and the patient died five minutes later.

Reflection Points from the Committee

- It is difficult in this case to clearly identify the cause of death in this patient. If a patient has an arrest shortly after a regional anaesthetic procedure, local anaesthetic toxicity should be considered as part of the differential diagnosis and consideration given to intralipid being used as part of the treatment.
- With any regional anaesthetic block, any top up bolus should be treated as a test dose (the dose may be intrathecal or intravascular) and the dose given adjusted accordingly.
- Procedures can be difficult and challenging regardless of how many times an operator has performed them before.
- It is important to recognize that the more attempts and the longer the procedure takes, the more likely it is that a complication will ensue.
- If it is not a lifesaving procedure, a more prudent course of action may be to abandon the procedure and pursue other treatment options.
- Lung ultrasound for diagnosis of pneumothoraces is very sensitive, however they are operator-dependent. Multiple rib windows should be used if assessing for a potential pneumothorax.

CASE 5

Summary

A patient aged in their early seventies was admitted for removal of a food bolus.

Background Medical History

They were a lifelong smoker and had a previous general anaesthetic two months prior – with midazolam, fentanyl and propofol.

Anaesthetic Details

For this anaesthetic they were given a rapid sequence induction with midazolam 1mg, fentanyl 100microg, propofol 110mg and suxamethonium 75mg. They were easy to intubate, using video laryngoscopy.

Events

Ventilation was immediately very difficult. The endotracheal tube position was rechecked with the video laryngoscope. The patient began to desaturate, and severe bronchospasm was suspected; adrenaline 50microg was given.

Sinus tachycardia was followed by bradycardia and then a loss of trace of the saturation probe occurred. CPR was commenced and salbutamol was given through the endotracheal tube. Rhythm was in pulseless electrical activity, ventricular tachycardia and ventricular fibrillation.

Adrenaline 5mg was used in total during the resuscitation and the patient was shocked twice. Ventilation did not improve during the entire event. Resuscitation was ceased after 20 minutes of no cardiac output.

The post-mortem imaging showed:

- ETT in correct position
- Left tension pneumothorax
- Two small right pneumothoraces
- Post-mortem tryptase levels 105microg/ml (can be artificially elevated after CPR)
- Total IgE 545 KU/L (markedly elevated)
- Suxamethonium IgE 0.2 KU/L (insignificant)

Reflection Points from the Committee

- This was likely an anaphylaxis event.
- In any prolonged resuscitation with high airway pressures it is worth considering the possibility of a pneumothorax.
- As taught in all Anaesthetic Crisis Courses the 4Hs (Hypoxia, hypovolemia, hypo/hyperkalaemia, hypo/hyperthermia) and 4Ts (Tension pneumothorax, thrombosis, tamponade and toxins) should be considered during an arrest.

CASE 6

Summary

A patient in their early seventies was booked for a gastroscopy. They were admitted the week prior with dehydration, urosepsis and melaena. An earlier gastroscopy was undertaken during this admission which showed a mass at the gastro oesophageal junction. A CT scan showed multiple liver and lung metastasis.

Background Medical History

The patient was obese with a history of alcohol dependence. A repeat gastroscopy was requested for ongoing melena.

Anaesthetic Details

High flow nasal prong oxygen was placed, and the patient was sedated with ketamine and propofol TCI. The patient had a large volume vomitus and desaturated. Bag-mask ventilation was applied. They continued to vomit, and no procedure was attempted.

Events

A discussion between the medical teams and ICU occurred. Given a pre-existing advance care directive was in place, no escalation in resuscitation was made. The patient was transferred to the ward for palliation and died six hours later.

Reflection Points from the Committee

- Gastroscopies should not be treated as quick low-risk procedures.
- Patients with known gastrointestinal pathology (mass, obstruction, inflammation etc) should be considered at high risk for an aspiration event.
- Rapid sequence inductions are recommended for this group of patients.
- Review of the abdominal CT would have helped assess the aspiration risk.

CASE 7

Summary

A patient in their mid-seventies was admitted for a revision amputation wound and cholecystectomy.

Background Medical History

Their background history included peripheral vascular disease with a failed leg bypass resulting in below knee amputation, wound infection and multiple debridements. Other co-morbidities included hypertension, atrial fibrillation and type 2 diabetes mellitus.

Anaesthetic Details

Standard non-invasive monitoring was applied, and the patient was induced with fentanyl 200microg, propofol 60mg and paralysed with rocuronium 60mg.

Events

The patient had severe bradycardia post intubation (HR 20-30), falling $ETCO_2$ and an unrecordable blood pressure. They did not respond to atropine 600microg. A cardiac arrest was called and cardiopulmonary resuscitation commenced. Adrenaline 1mg was given, with return of spontaneous circulation occurring one minute later.

An arterial and central line were inserted, and an adrenaline infusion was commenced. Transthoracic echocardiogram showed significant right ventricular dilatation and very poor left ventricular function. The patient was transferred to the ICU. After a multidisciplinary meeting a decision was made not to pursue operative management. The patient died one hour later.

Reflection Points from the Committee

- Vascular patients have very little physiologic reserve owing to their multiorgan dysfunction.
- Given that the patient was having an operation with considerable physiologic stress (laparoscopy) after a prolonged complicated hospital stay, a preoperative assessment could have included a transthoracic echo to indicate cardiac function and pulmonary artery pressures.
- A preoperative arterial line would be advisable.
- Discussing advanced care directives with the patient and their families prior to embarking upon major surgery in elderly or frail patients is recommended.

CASE 8

Summary

The following is a summary of The Coroner's Report (2019/00038771).

A toddler presented to hospital with a severe finger injury. They weighed 9.4kg, height was 77cm (10th percentile for age) and they were otherwise healthy. The injury was examined in the emergency department and assessed as a deep degloving injury to the finger. To facilitate adequate assessment and treatment of the injury, a general anaesthetic was deemed necessary.

Anaesthetic Details

An anaesthetic consultant and registrar would administer the anaesthesia while another anaesthetic consultant was asked to be available in the facility to assist immediately if needed. The plan was for a rapid sequence induction.

The patient was pre-oxygenated and induced with fentanyl and propofol. They were intubated. Post intubation there was audible leak, not improved by further inflating the cuff, a small $ETCO_2$ trace and the oxygen saturations were below 90%.

Events

The second consultant was called and attended. A decision was made to replace the endotracheal tube. The patient was reintubated with a good view of the vocal cords.

Once again, an audible leak was heard. Chest auscultation revealed bilateral wheeze. It was noted that there were high airway pressures with a minimal $ETCO_2$ trace present. Bronchospasm or perhaps anaphylaxis was queried as the cause. Salbutamol, fentanyl and suxamethonium were administered.

The patient continued to deteriorate – now becoming hypoxic and bradycardic. Atropine was administered without any response. Cardiopulmonary resuscitation was commenced, adrenalin was administered, a lung ultrasound was performed and a blood gas taken during this time. Cardiopulmonary resuscitation continued for 40 minutes unsuccessfully. The patient died one hour post induction.

The post-mortem examination revealed: "The endotracheal tube lies in the oesophagus, with its balloon inflated. The tip of the ETT lies at the T3 level."

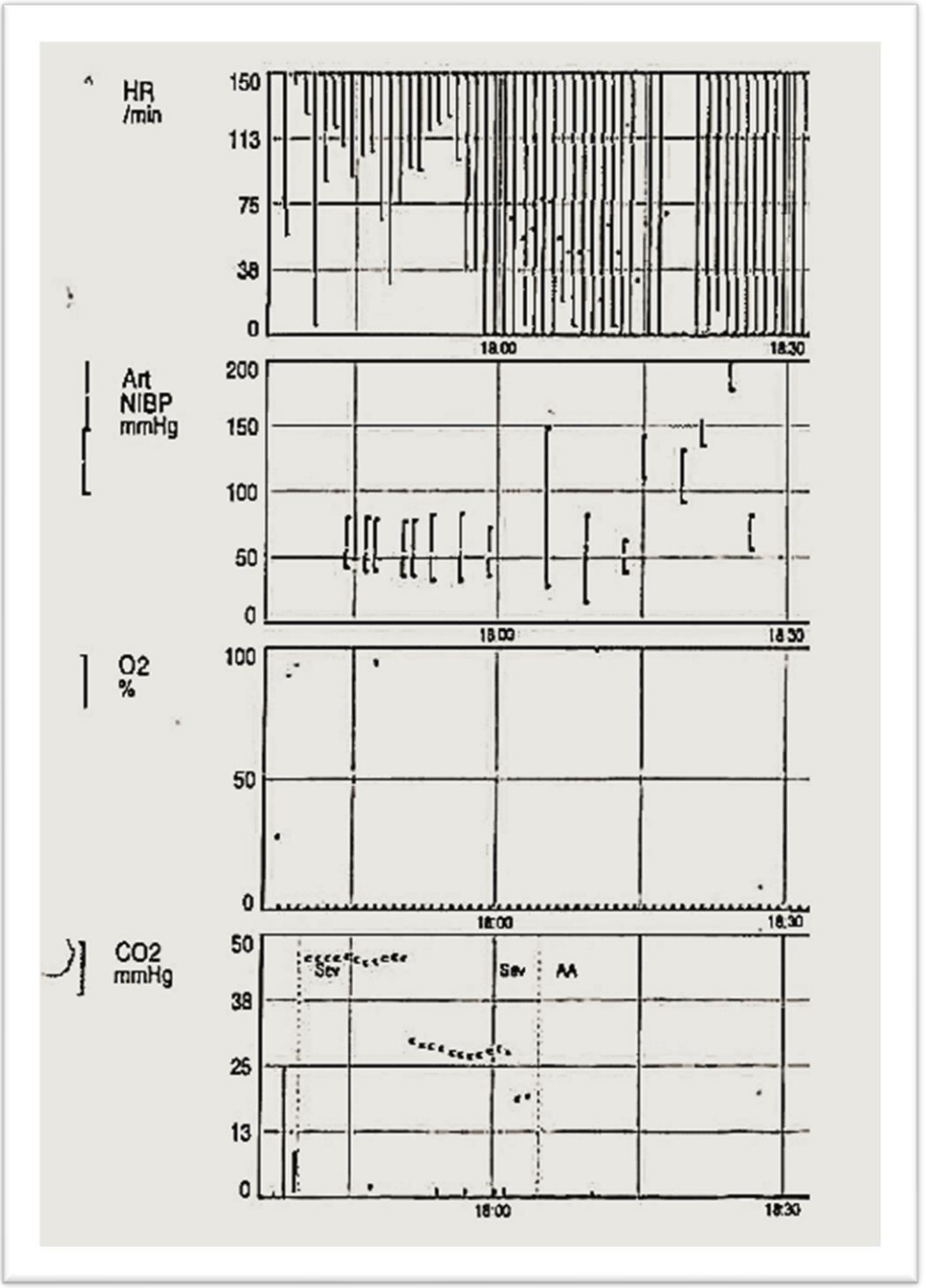

Image 1: Anaesthetic trends for the case.

Reflection Points from the Committee

- Paediatric anaesthesia is challenging.
- Paediatric anaesthesia under two years of age requires a great deal of expertise.
- As per ANZCA document PG29 (Guideline for the Provision of Anaesthesia to Children):

Occasionally, urgent care needs to be delivered to children whose age, comorbidity or procedure-type falls outside any individual anaesthetist's scope of practice for planned care.

In the interest of achieving the best outcome for the child, the clinical team will need to adapt and utilise available resources, including any established local protocols, and, where relevant, distant resources such as expert advice should be sought.

Things to consider:

- If there is no CO_2 trace, you must assume the tube is not placed in the trachea.

  (No trace = wrong place). If in doubt, take it out and replace it.
- If there is no CO_2 trace and you are convinced that the ETT is correctly placed, take steps to confirm placement (video-laryngoscope or bronchoscope).
- Use equipment that is familiar and available. If a MAC 2-blade is not available, a MAC 3 can be used in an emergency (inserted carefully) to achieve the same purpose.
- If there is still doubt, it is better to bag-mask ventilate the child than risk ventilating the oesophagus.

Category 2 Deaths

These deaths are classified as: Where there is some doubt whether the death was entirely attributable to the anaesthesia, or other factors under the control of the anaesthetist.

CASE 9

Summary

A patient in their mid-nineties presented for a short gamma nail for fractured femur.

Background Medical History

Their background history was complicated, and included: dementia (nursing home resident), ischaemic cardiomyopathy (left ventricular ejection fraction 45% four years ago), atrial fibrillation, chronic renal failure, and chronic airways limitation.

On admission the patient was hypothermic, hypotensive and coagulopathic (INR 2.7). Urosepsis was the presumptive diagnosis. They were given antibiotics (cephazolin and gentamicin) and Prothrombinex®-VF.

A discussion occurred between the treating teams and the family regarding waiting for the urosepsis to improve or proceeding with an operation. The latter was decided upon.

Anaesthetic Details

On arrival in the bay the patient was agitated and became violent when anyone touched them. No attempt at further intravenous or arterial access was made because of this. They were induced with sevoflurane 2%, fentanyl 50microg and propofol 10mg with a metaraminol infusion running. A laryngeal mask airway was inserted.

Post induction the patient's blood pressure dropped to 70mmHg. Intravenous adrenaline (500microg) was used to correct the hypotension. The blood pressure improved to 150mmHg. An arterial line was attempted but problematic to site.

Events

A team discussion ensued and a decision made to abandon the procedure. The laryngeal mask airway was removed, a femoral nerve catheter was sited. The patient transferred to recovery, and then the ward, for comfort-based care. The patient died the next day.

Reflection Points from the Committee

- Urosepsis is a life-threatening event. Multiorgan dysfunction with cardiac compromise can occur and this is made worse by anaesthesia.
- While appreciating that certain surgery is urgent, in cases like this, there is time for optimization of a patient prior to embarking on surgery.
- This patient had time for correction of fluid status, coagulopathy and treatment with antibiotics prior to surgery.
- Analgesia could have been provided for the patient via femoral nerve catheter whilst awaiting surgery.
- Goals of treatment should be established with the patient and family prior to surgery and the option of comfort care made available to them.

CASE 10

Summary

A patient in their early eighties required a gastroscopy and insertion of a percutaneous endoscopic gastrostomy (PEG) tube.

Background Medical History

The patient had rapidly progressing motor neuron disease (bed bound, bulbar dysfunction- recurrent aspirations, incomprehensible speech, full assistance in activities of daily living). Their oxygen saturations were 96% on 30% oxygen delivered via high flow nasal prongs. Arterial blood gases (ABGs) (30% HFNPO): pH 7.41; pO_2 71; pCO_2 43; HCO_3 27; Lac 0.9; BE 2. They had new atrial fibrillation; chest x-ray showed a left sided pleural effusion with collapse.

Anaesthetic Details

The patient was sedated with alfentanil 100microg and propofol 10mg. High flow nasal prong oxygen (HFNPO) 100% was used. The gastroscopy commenced; two minutes into the procedure the patient appeared to obstruct and desaturate. The gastroscope was removed and a cardiac arrest was called. A laryngeal mask airway was inserted and ventilated with a Laerdal bag initially then pressure support used. Oxygen saturation was back up to 95%. ABGs: pH 7; 21PO_2 213; pCO_2 73; HCO_3 29; BE -1; Lac 1.4

Events

The patient emerged from sedation and the laryngeal mask airway was removed and HFNPO reinstated. Given the intraoperative events a decision was made to abandon the procedure.

The patient again started to deteriorate. Oxygen saturations were 85%, and the patient was not responding to voice. Bag-valve-mask ventilation commenced, and saturations were now 70%. A decision was made to intubate – propofol 40mg and suxamethonium 100mg used. On 100% oxygen post intubation the oxygen saturations 70-80%.

After a discussion between treating teams and intensive care, treatment was withdrawn in the operating room. The patient was extubated and died ten minutes later.

Reflection Points from the Committee

- This patient was at the end of their natural life.
- The decision for the procedure should have been questioned.
- Given the extremely weak bulbar muscular function, if the procedure were to take place performing it under throat spray and local anaesthesia alone could have been considered.

CASE 11

Summary

A patient aged in their late seventies had a gastroscopy for dysphagia.

Background Medical History

Recent diagnosis of right upper lobe mass and Horner's syndrome on a background of severe emphysema. Baseline oxygen saturation was 88-92% on room air.

Anaesthetic Details

Nasal prong oxygen was applied but there was no real improvement in oxygen saturations. A face mask was used to improve oxygen delivery and saturations rose to 95%. Sedation was started; alfentanil 200microg given and TCI propofol (Marsh) commenced at 1microg/ml and then increased to 2microg/ml.

Events

The case commenced; a quick procedure lasting two minutes. There was no intraluminal cause of obstruction found. The patient was stable and breathing spontaneously. A decision was made to remove monitors and transfer the patient to recovery. The patient developed a sallow colour, and a saturation probe was reapplied. A poor trace was noted. Jaw thrust was applied and then a bag-mask ventilation was commenced. The patient was unresponsive.

ECG showed an initial tachycardia then bradycardia. A cardiac arrest was called. Atropine 600microg was given. The blood pressure was un-recordable and cardiopulmonary resuscitation (CPR) was commenced. Ten cycles of CPR were given with no success. The patient died 60 minutes after entering the room.

Reflection Points from the Committee

- Without any stimulation post procedure, the synergistic effect of Propofol and Alfentanil may have caused an apnoeic episode during transfer.
- Respiratory-compromised patients are extremely sensitive to opioids. Performing the procedure under propofol alone could have been considered or with throat spray and no additional anaesthesia.
- Unwell patients and those with a pre-procedure oxygen requirement should have continuous pulse oximetry applied, during transfer from the operating table (if used) to the patient's bed and then to PACU.
- Given the patient's poor respiratory status, could another test have been more suitable e.g. Barium Swallow?

CASE 12

Summary

A patient in their early nineties required Endoscopic Retrograde Cholangiopancreatography (ERCP). They presented with acute cholecystitis / cholangitis which was not settling with conservative management.

Background Medical History

The patient's comorbidities included: ischaemic heart disease – troponin of 471 on admission; cardiomyopathy with moderate left ventricular impairment; severe tricuspid regurgitation; moderate pulmonary hypertension (on a transthoracic echocardiogram a year prior); mechanical mitral valve; permanent pacemaker; atrial fibrillation; chronic renal impairment. They were not deemed to be a suitable surgical candidate. A discussion with the patient and family pre-operatively outlined the high-risk nature of proceeding.

Anaesthetic Details

An arterial line was inserted. The patient was induced with fentanyl 25microg, propofol 40mg and they were paralysed with suxamethonium 100mg, and intubated.

Events

Immediately post induction their blood pressure fell to 70mmHg. Boluses of metaraminol 1mg + 1mg + 2mg had no effect. The ECG remained paced with a present but poor arterial trace. A cardiac arrest was called. Adrenaline 100microg + 200microg + 200microg was given again with no effect. CPR was commenced. The patient had three cycles of CPR including delivery of two shocks with no return of cardiac output. The patient was declared dead.

Reflection Points from the Committee

- ERCP patients are often unwell.
- Invasive blood pressure monitoring and securing the airway with an endotracheal tube in this case was the sensible approach.
- Despite minimal anaesthetic agents being given it was enough to cause cardiovascular collapse.
- Comfort care could have been offered as an option.

CASE 13

Summary

A patient in their late fifties had a hip washout.

Background Medical History

The patient had a background history of end stage renal failure, ischaemic heart disease, atrial fibrillation and severe pulmonary hypertension. They were admitted to hospital two days prior with septic shock, requiring vasopressors. They had episodes of asystole and slow atrial fibrillation while in ICU; and one episode of ventricular standstill post dialysis.

Anaesthetic Details

The patient was induced with atropine 600microg, midazolam 1mg, fentanyl 150microg, propofol 50mg, ketamine 30mg and paralysed with suxamethonium 100mg.

Events

Post induction the patient had severe hypotension not responding to metaraminol. Adrenaline 600microg in divided doses were administered. Blood pressure overshoot resulted temporarily. There were subsequent recurring episodes of severe hypotension requiring CPR and adrenaline boluses. Atrial fibrillation was observed at each rhythm check.

The case was discussed with the intensive care physician and a decision was made to cease resuscitation.

Reflection Points from the Committee

- The synergistic effect of induction drug combinations can precipitate severe hypotension.
- Simplifying induction regimens can reduce this.
- Filling status should be optimal pre induction to help mitigate this blood pressure drop.
- Pulmonary hypertension is a very serious co morbidity. It should be thought of in terms of being more worrying than aortic stenosis.
- Avoidance of factors which will increase pulmonary hypertension (hypoxia, hypercarbia, hypothermia, pain response and acidosis) should be prioritized.

CASE 14

Summary

A patient in their early eighties clutched their chest before falling backwards, hitting their head, resulting in an unstable cervical spine fracture and fractured ribs. CPR was administered by bystanders, with a return of spontaneous cardiac output at 8 minutes. Glasgow coma scale was 14. The patient required a posterior occiput to T3 fusion.

Background Medical History

Background history was extensive: ankylosing spondylitis; ischaemic cardiomyopathy with left ventricular ejection fraction 32% (pre this event); severe pulmonary hypertension; automatic implantable cardioverter defibrillator (AICD) insitu; Type 2 diabetes mellitus; chronic kidney disease; unprovoked DVT in calf, on anticoagulants.

Anaesthetic Details

The patient was induced with fentanyl 150microg, propofol 50mg and paralysed with rocuronium 50mg.

Events

Post induction the blood pressure fell to 50mmHg. CPR was commenced and adrenaline 1mg given. The blood pressure recovered with overshoot in two minutes. Transthoracic echocardiogram was performed showing akinetic / minimally contracting LV.

Bag-mask ventilation was performed with hard collar on during CPR and a laryngeal mask airway was inserted post return of cardiac output, which was then changed to an endotracheal tube with a CMAC D blade (laryngoscope) and bougie.

Midazolam 5mg was given as sole anaesthetic agent after induction. The patient had a cardiac arrest a few minutes later. Adrenaline 0.5mg was given and output was regained 2 minutes later. A femoral central line was inserted and adrenaline infusion commenced.

There was discussion between ICU, anaesthetics and the surgical team, and a decision was made to palliate the patient.

Reflection Points from the Committee

- After a major cardiac event, it would be wise to let the patient recover for at least 48 hours to allow investigations and management of potential complications to occur under the care of a cardiologist prior to undertaking urgent surgery.
- Unstable fractures of the spine put the spinal cord at risk due to physical displacement of the cord by vertebral bodies which are not in normal alignment. In these cases, the spine needs to be returned to its normal position to prevent permanent spinal cord damage.
- If surgery cannot be delayed, a preoperative cardiac echo would be helpful prior to undertaking a procedure.
- Central venous access should be considered in these patients prior to induction to allow the administration of vasopressors (+/- pulmonary vasodilators).

CASE 15

Summary

A patient in their early seventies presented for gastroscopy. They had a long and complex admission - small bowel obstruction with acute renal failure requiring dialysis.

Background Medical History

Medical history included: type 2 respiratory failure; obstructive sleep apnoea; morbid obesity; heart failure; type 2 diabetes mellitus; metastatic endometrial cancer.

Anaesthetic Details

The gastroenterologists felt that the likely gastric volume would be low as the patient had been fasting for more than 48 hours and no mechanical obstruction in the bowel.

On arrival in the bay the patient was noted to be tachypneic. Their respiratory rate was 25min and oxygen saturations on room air was 92%.

An awake procedure was planned. The airway was tropicalized with three pumps of co-phenylcaine forte spray aerosol. Within 15 seconds the patient felt nauseous and vomited solid matter. Once settled, high flow nasal prong oxygen was applied; at 10L/min, oxygen saturations were 91%.

A discussion occurred with the gastroenterologist about the value of proceeding who was convinced that it would be in the patient's best interests to continue.

Events

A rapid sequence induction was performed with propofol TCI (target 2microg/ml) and rocuronium 50mg. There was obvious supraglottic soiling on laryngoscopy. The patient was very difficult to ventilate post intubation (peak airway pressure of 40-50 cmsH20 to achieve a tidal volume of 150mls).

Salbutamol was given and a bronchoscopy/lavage performed with minimal improvement.

An arterial line was inserted. Blood gases showed a PaO_2 of 106 and $PaCO_2$ of 64 (FiO_2 of 32%).

The gastroscopy was commenced revealing a full stomach and further procedures were abandoned. The patient was transferred to intensive care ventilated. They continued to deteriorate and died later that day.

Reflection Points from the Committee

- Any patient with bowel pathology is at high risk of aspiration. A rapid sequence induction with cricoid pressure is indicated.
- Anaesthetists should assess the aspiration risk of a patient for themselves. They should not be reassured by someone else about the relative risk involved.
- Do not be comforted when a proceduralist says that they have the ability to suction out any gastric contents that might be present. This will not prevent an aspiration occurring. The suction ports on a gastroscope are only useful for liquid material, not solid material.

CASE 16

Summary

A patient in their late seventies had fixation of a femur fracture.

Background Medical History

Their background history was significant for: moderate to severe pulmonary hypertension; severe tricuspid incompetence; atrial fibrillation; type 2 diabetes mellitus; obstructive sleep apnoea; chronic kidney disease.

Anaesthetic Details

While on the patient's bed, under propofol sedation (TCI 2microg/ml), a femoral nerve and fascia iliac block was performed. A radial arterial line was inserted and then a laryngeal mask airway inserted. With a metaraminol infusion running (at 4mls/hr) the patient was then transferred onto the operating table.

Events

Upon transfer to the operating bed the patient's blood pressure fell. Adrenaline 100microg was given and cardiopulmonary resuscitation was commenced. The patient progressed to rapid atrial fibrillation. A decision was made to abandon the procedure and palliate the patient.

Reflection Points from the Committee

- The timing of transferring from bed to operating bed can be distracting for the anaesthetist (e.g., positioning/ lines etc./ discussions within different members of theatre team), so it is important to remain vigilant at this time or designate someone to watch the monitors (and set monitor alarms to BP range that is being targeted).
- Sedation in a patient with pulmonary hypertension should be carefully considered. The subsequent respiratory depression will lead to an increased arterial CO_2 leading to worsening pulmonary hypertension.
- This worsening of pulmonary hypertension may result in right heart compromise. This is very difficult to manage.
- Arterial lines and blocks can be done with local anaesthetic alone.
- Intubation of patients with moderate to severe pulmonary hypertension is recommended to avoid hypoxia and hypercarbia during the case.

Category 3 Deaths

These deaths are classified as: Where both surgical and anaesthetic factors were thought to have attributed to the death.

CASE 17

Summary

A patient in their early seventies required a craniotomy and excision of meningioma.

Background Medical History

The patient was known to have a history of ischaemic heart disease having had a quadruple bypass the year before. A recent review was carried out by the cardiologist for exertional dyspnoea. A CT coronary angiogram was performed which was concerning for graft occlusion. A subsequent stress test (four months prior to surgery) showed ST depression in the inferolateral leads but the study was deemed negative due as no regional wall abnormality was detected.

The patient's aspirin was ceased a week prior to surgery by the neurosurgeons. Their anti-anginals (metoprolol and isosorbide mononitrate) were also ceased, but it is unclear by whom or why. Their transthoracic echocardiogram showed moderate aortic stenosis with a preserved ejection fraction. The pre-operative bloods were normal.

Anaesthetic Details

The patient was induced with midazolam 2mg, propofol TCI 4microg/ml, remifentanil 4microg/ml and paralysed with rocuronium and intubated. Cephazolin and mannitol 40mg was administered.

Events

About an hour and a half into the case the patient started to become unstable. There was sudden ST depression and then ST elevation in lead II. The patient became tachycardic to 130 min and blood pressure fell to 50mmHg. $ETCO_2$ fell to 28mmHg, and Entropy declined.

The surgeons were informed and the surgery was ceased (bone flap had just been removed). The patient was placed head down and field flooded with normal saline. An emergency was called.

Adrenaline boluses (10microg followed by 50microg) were given along with 2L of Hartmann's solution and packed cells.

Adrenaline and noradrenaline infusions commenced. Some stability was achieved, and the surgeons replaced the bone flap and abandoned surgery. Transoesophageal echocardiography (TOE) showed right ventricular failure but hyperdynamic left ventricle.

About 20 minutes later there was further deterioration. Blood pressure dropped to 30/20mmHg and $ETCO_2$ less than 15mmHg. CPR was commenced and phenylephrine and vasopressin administered.

A cardiothoracic surgeon was consulted with view to putting the patient on ECMO. Lines were placed and bypass commenced, however, the volume was not able to be maintained due to ongoing bleeding (head and groin). A decision was made to cease resuscitation.

Reflection Points from the Committee

- This patient was a “public in private” patient. In many cases information is not made available to the facility actually performing the procedure. In this case they were seen the day before surgery in the private preadmission clinic at the end of the day, not allowing adequate time for information acquisition nor optimization planning to take place.
- While acknowledging there is a pressure to proceed in certain situations, it is important to recognize in non-emergency situations where you have information that doesn’t make sense, further assessment is warranted (including a second cardiology opinion) prior to proceeding with surgery.
- While ECMO is a lifesaving procedure, it requires heparinization of the patient at initiation and for maintenance. This will result in bleeding from the surgical site which may be difficult to control.

CASE 18

Summary

A patient in their early sixties had a laparoscopic cholecystectomy.

Background Medical History

The patient was admitted with acute cholecystitis on a background of intellectual impairment and stable ischaemic heart disease. Their pre-operative oxygen saturation was 90-93% on room air. The patient denied any respiratory disease.

Anaesthetic Details

The patient was pre-oxygenated and induced with midazolam 2mg, fentanyl 100microg, propofol 100mg and paralysed with rocuronium 40mg. They were intubated.

Events

After pneumoperitoneum peak, pressure to achieve a tidal volume of 400mls was 31 cmsH20. Bronchospasm was suspected and treated with salbutamol puffs and 10mmol magnesium sulphate and ketamine 20mg. Oxycodone 5mg, paracetamol and cephazolin were administered.

The case was completed in one hour and sugammadex given for reversal. The patient was extubated and transported to recovery. Fifteen minutes later they were not making any respiratory effort but moving their limbs. Oxygen saturations were 80% on a Hudson mask. Bag mask ventilation commenced and saturations rose to 100%. Further sugammadex 200mg, naloxone 400microg, and flumazenil 200microg was given. Twenty minutes later the patient was still not improving so a decision was made to reintubate (propofol and suxamethonium given) and transfer to ICU.

The patient's family was contacted after admission to ICU. The family shared that the patient suffered from muscular dystrophy. The patient walked with the aid of a frame and in the last 18 months had a worsening of his breathing with only shallow breaths being able to be taken.

The patient was extubated onto bilevel positive airway pressure (BiPAP) the following day but was poorly tolerant of this. They were switched to high flow nasal prong oxygen. Their respiratory failure worsened, and the patient died one day after surgery.

Reflection Points from the Committee

- Preoperative assessment is the cornerstone of safe anaesthesia.
- Patients with cognitive impairment or intellectual disability cannot be relied upon for accurate information. Corroboration with information from other sources (e.g., general practitioner, relatives, old anaesthetic records) should be sought.

CASE 19

Summary

A patient in their mid-forties had laser fragmentation of staghorn calculus.

Background Medical History

The patient's background was significant for: morbid obesity – BMI 45; cardiomyopathy – ejection fraction 40% (seven years ago); atrial fibrillation; mild cognitive impairment; previous ICU admission for sepsis; smoker. Vital observations on admission to the surgical unit were: oxygen saturations 94% (drop to 82% with exertion), heart rate 110/-min; atrial fibrillation, blood pressure 96/62mmHg, and respiratory rate 18/-min.

Anaesthetic Details

The patient was pre-oxygenated and then induced with fentanyl 100microg, propofol 180mg, and paralysed with suxamethonium 150mg. They were intubated and placed in the lithotomy position and the case commenced. Cephazolin 2g was given.

Events

About 45 minutes into the case the heart rate started to rise to 120 min, the pulse oximeter trace decreased and the $ETCO_2$ dropped to 20mmHg. No convincing pulse could be felt. Adrenaline 100microg was administered and an emergency was declared. Surgery was ceased, the patient was repositioned to the supine position and cardiopulmonary resuscitation commenced.

An arterial line was inserted, adrenaline and fluids were given. Calcium gluconate and bicarbonate were also administered. A transthoracic echocardiogram showed no tamponade or pneumothorax. The patient remained in pulseless electrical activity. CPR continued and blood started coming up from the endotracheal tube. Resuscitation was ceased and the patient died 90 minutes post induction.

Reflection Points from the Committee

- It is worth repeating investigations prior to surgery when the last documented results are abnormal, and a large period of time has passed, and when there is suspicion that those results are now worse.
- Staghorn calculi are associated with high morbidity.
- Manipulation of staghorn calculi can result in release of a large bacterial load leading to overwhelming urosepsis.
- Urosepsis can present with cardiovascular collapse intraoperatively with very little preceding deterioration.

Data breakdown for Group A deaths (2021)

The following data analysis depicts the details of the 56 anaesthesia-related deaths classified by SCIDUA in 2021 as Category 1, 2 or 3.

Of these, 52 cases had specialists as the primary anaesthetist, with 34 general anaesthesia inductions performed. There were 7 sedations deaths occurring in patients aged between 70 and 89 years.

There is also data analysis provided in a few additional figures for all deaths (n=306) classified by SCIDUA in 2021. Figure 1 below shows the distribution of notifications by year of death, with 59.48% occurring in 2021.

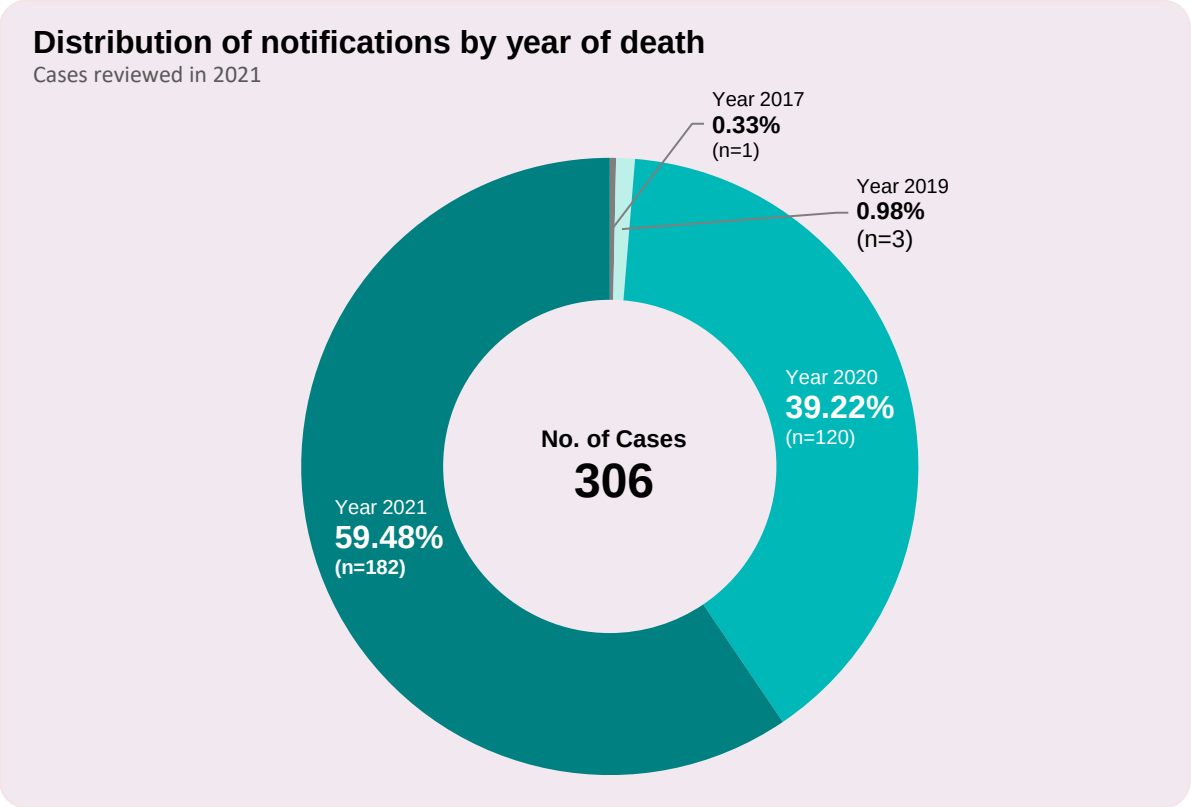

Figure 1: Distribution of notifications by year of death.

Grade of anaesthetist and type of anaesthesia

The grade of anaesthetist and the type of anaesthetic used may be an influence on patient outcomes. Review of the 56 anaesthesia-related deaths in 2021 identified that:

- Anaesthetic-related deaths where general-anaesthesia was administered accounted for 64.28% (n=36) of cases reviewed by the committee in 2021. In 94.44%% (n=34) of these deaths the general anaesthetic was administered by a specialist anaesthetist.
- Regional anaesthesia was administered by a specialist anaesthetist in 46.43% (n=26) of deaths with two episodes of regional anaesthesia administered by a trainee.
- Sedation was administered by a specialist in all of the seven deaths reported. All patients were aged 70 or over.
- Anaesthesia (general = 2; regional =2) was administered by a trainee anaesthetist in 5.36% (n=3) of the anaesthesia-related deaths.

Figure 2 shows the distribution of the type of anaesthesia as administered by the grade of anaesthetist for cases reviewed in 2021.

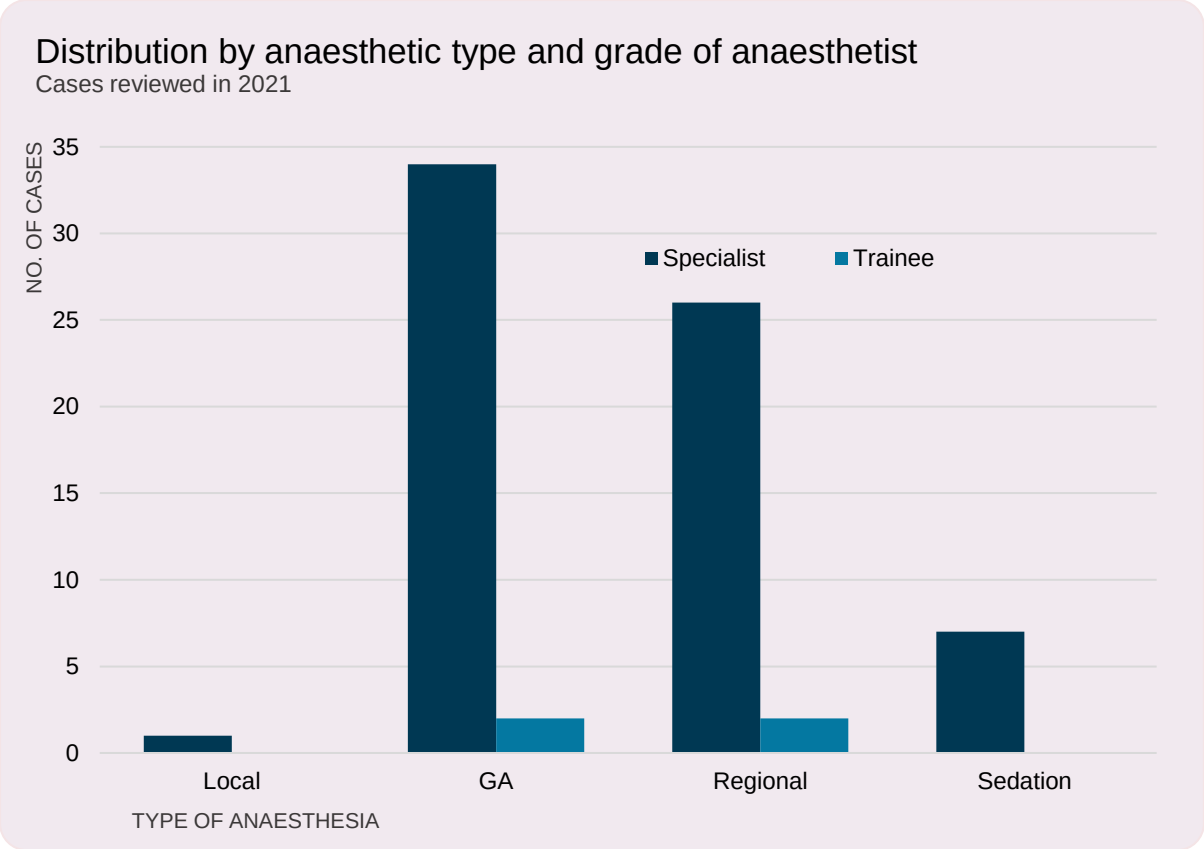

Figure 2: Frequency distribution of anaesthetic-related deaths (n=56) for 2021 by grade of anaesthetist and type of anaesthesia administered.

Distribution of specialty

Orthopaedic surgery was the most frequent surgical specialty for anaesthesia-related deaths in 2021 representing 51.79% (n=29) of cases, which follows a similar reporting pattern in 2020 when there were 28 cases. Figure 3 shows the surgical speciality distribution for the 2021 anaesthesia-related deaths.

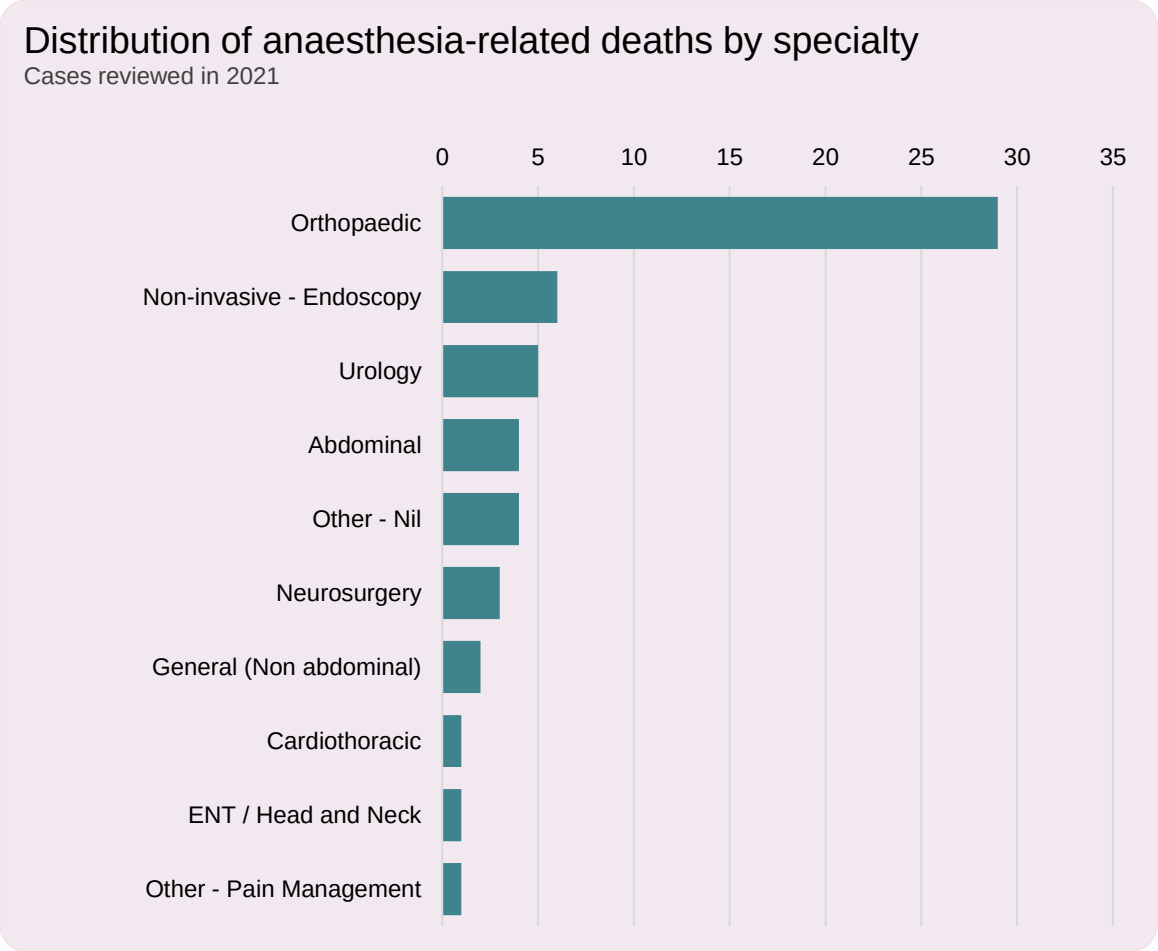

Figure 3: Distribution of specialty for anaesthesia-related deaths 2021.

Location of death

Figure 4 below shows the actual location of death for deaths occurring within 24 hours of anaesthesia or sedation being administered to a patient. In 2021, 63% (n= 193) of deaths occurred in the ICU/HDU, which is consistent with previous years.

Deaths that occur under the anaesthetist's supervision, either in the operating room, procedural room or in the recovery room, are also shown. These represent almost a quarter of the deaths at 24.5% (n=75); reduced to 19.6% for only the operating or procedural room deaths.

Of the 64 deaths that occurred in the operation theatre or procedural room, 16 were attributed to anaesthesia-related factors, one was deemed as un-assessable, and two were excluded. Anaesthesia played no part in the remaining deaths (n=45).

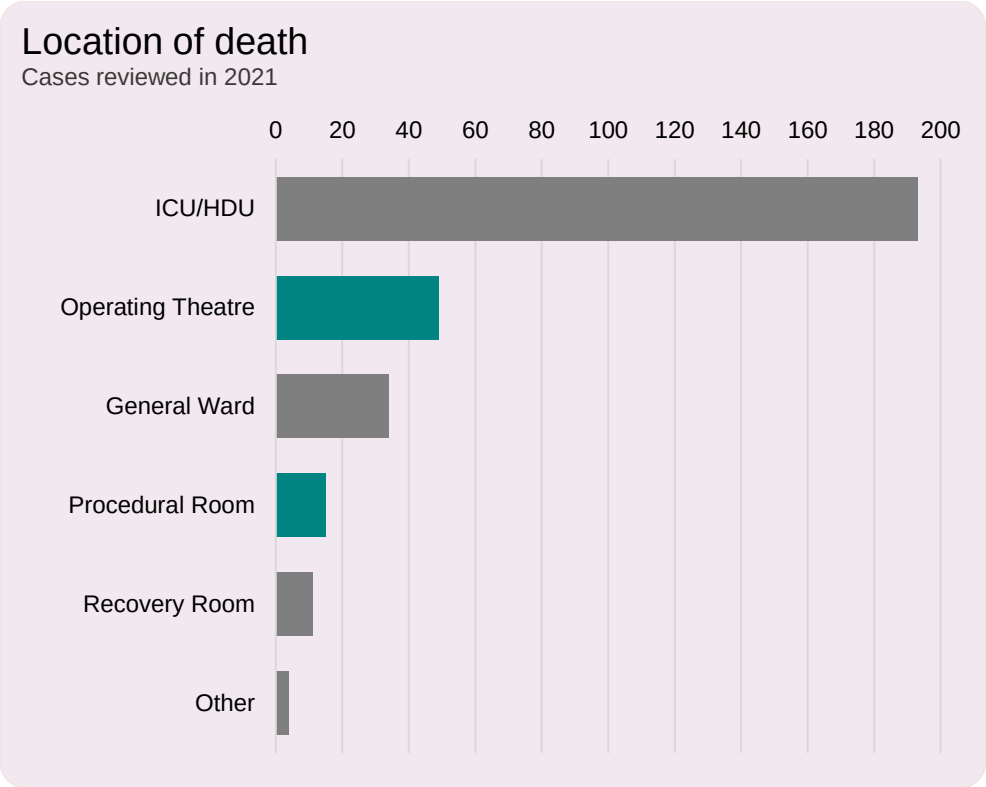

Figure 4: Distribution of anaesthesia-related deaths by location in hospital for 2021.

A quarter of the deaths that occurred within the operating room or procedural room, 25% (n=16,) were attributable to anaesthesia. The majority of the operating room or procedural room deaths, however, not deemed attributable to anaesthesia at 70% (n=45) as shown in Figure 5, on the following page.

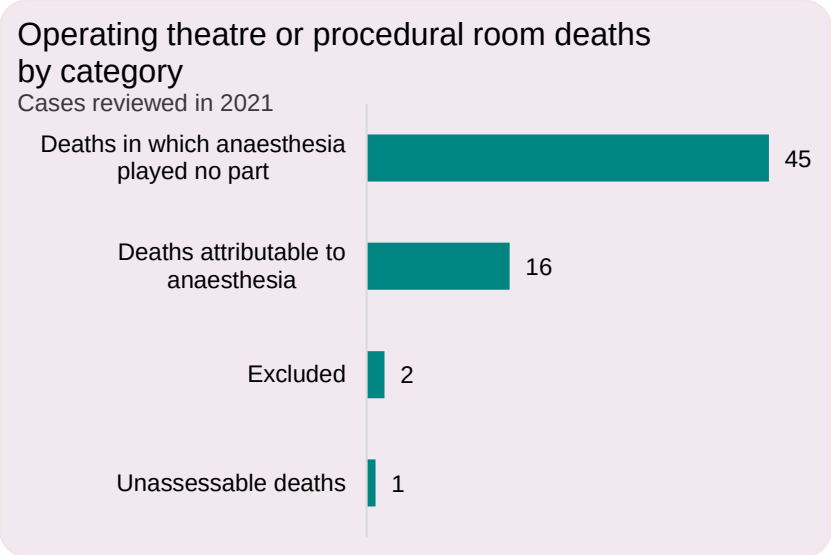

Figure 5: Operating theatre or procedural room deaths 2021.

The majority of the 45 deaths that occurred in the operating theatre or procedural room where anaesthesia played no part were classified as inevitable deaths (86.66%, n=39). The other six deaths were classified as Category 4 deaths, with one of these concerning a 33-year-old patient graded as ASA 1. Patient ages ranged from 22 (multi-trauma) to 96 years (orthopaedics). Figure 6 below shows the associated speciality and gender for deaths in the operating theatre or procedural room where anaesthesia played no part.

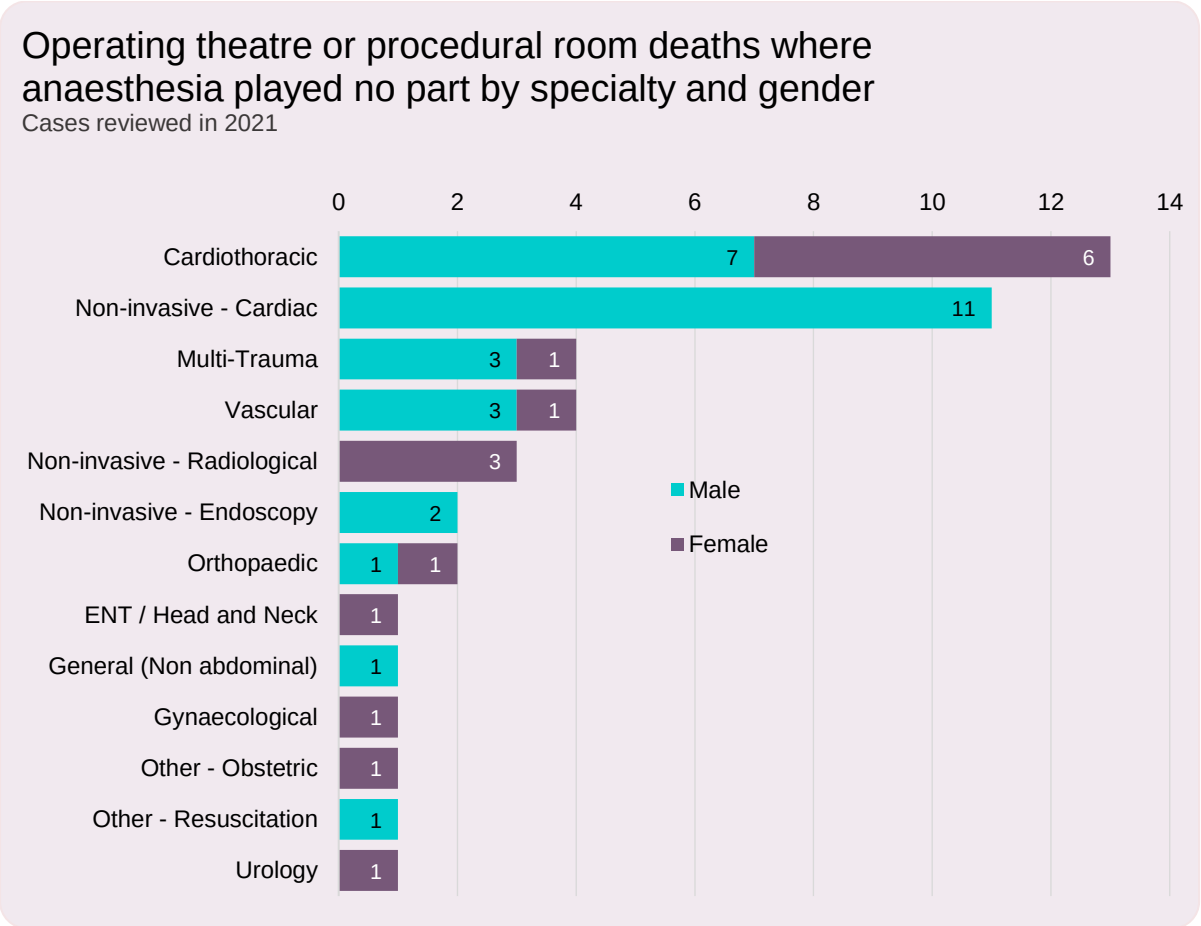

Figure 6: Speciality and gender for deaths in the operating theatre or procedural room where anaesthesia played no part.

Hospital type

Figure 7 shows the anaesthesia-related deaths type of hospital. As expected, most of the deaths occur in either metropolitan public teaching or non-teaching hospitals representing a combined 57.14% (n=32) of deaths.

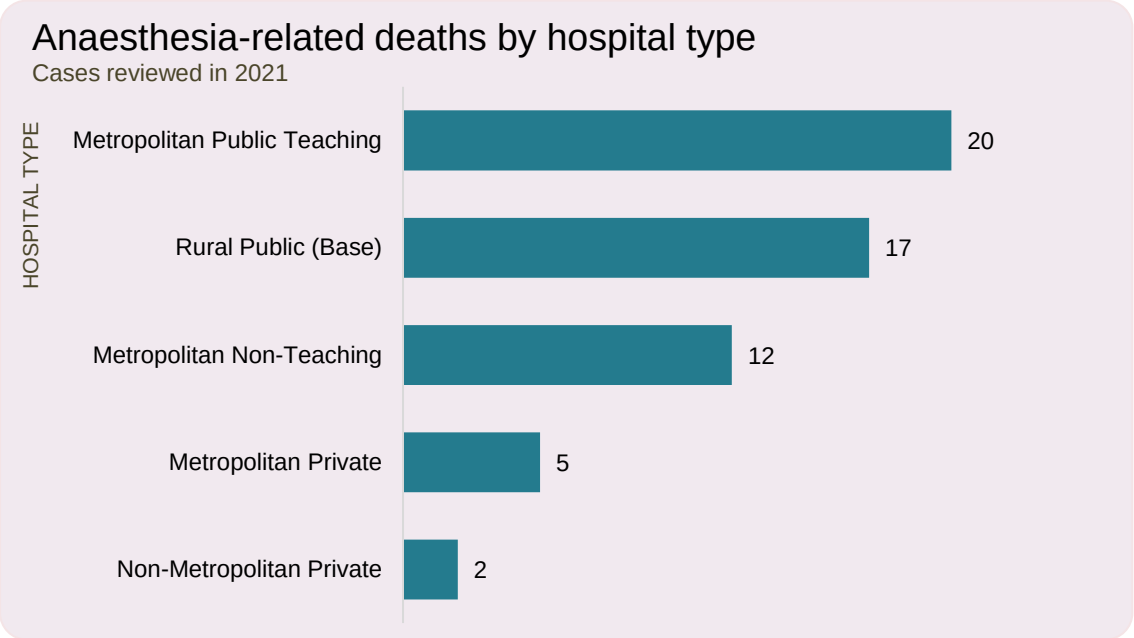

Figure 7: Anaesthesia-related deaths by type of hospital, 2021.

Hospital level

SCIDUA classifies hospitals into six levels, using a numerical system based on, but not identical to, the NSW Guide to Role Delineation of Health Services[2], as follows in Table 2:

Level 6	A multi-disciplinary hospital, which provides facilities for most or all surgical sub-specialties and the intensive care environment to support them. Specialist and sub-specialist anaesthetic staff are on site during the day and anaesthetic registrar cover is on site 24 hours a day. This classification also applies to where a hospital is designated as a trauma centre.
Level 5 Level 5 P Level 5 R	A hospital which is multi-disciplinary, but only provides some sub-specialty surgery and anaesthesia, with an appropriate post-operative environment. Specialist and sub-specialist anaesthetic staff are on site during the day and anaesthetic registrar cover is on site 24 hours a day, or available within 10 minutes.
Level 4 Level 4 P	A multi-disciplinary hospital, which does not cater for all surgical specialities, but accepts some trauma and provides a lower level of intensive care, referring any patients in need of specialised life support to a higher-level facility. Specialist anaesthetic staff are on site during the day and provide an on-call service after hours.
Level 3 Level 3 P	A hospital or day centre which undertakes a limited range of procedures but does not have the capability to care for high-risk patients or surgery which necessitates high-level post-operative care. Specialist anaesthetic staff are on site during the day.
Level 2	A facility at which anaesthesia or sedation is provided to enable a single procedure to be undertaken on good-risk patients (such as stand-alone ECT or dentistry).
Level 1	Any other location which anaesthesia or sedation is administered e.g., a dental office.

Table 2: Description of hospital level classifications.

*Note: For institution, hospital or facility that is in regional NSW, the suffix **R** is added. For private institutions, hospitals or facilities, the suffix **P** is added.*

[2] NSW Ministry of Health, 2016, Guide to the Role Delineation of Health Services
http://www.health.nsw.gov.au/services/Publications/role-delineation-of-clinical-services.PDF

Hospital Level

Review of the 56 anaesthesia-related deaths shows:

- 35.7% of anaesthesia-related deaths (n=20) occurred in metropolitan public teaching hospitals, with 73.21% of anaesthesia-related deaths (n=41) occurring in Hospital Levels 5, 5P, 5R and 6.

These facilities are representative of high volume, higher care acuity and emergency surgeries.

- 25% of deaths (n=14) occurred in rural public hospitals.
- 21.42% of deaths (n=12) occurred in metropolitan public non-teaching hospitals.
- 8.92% of deaths (n=5) occurred in metropolitan private hospitals.

Of the Level 5 hospitals, 55% (n=11) of deaths were classified as Category 3 deaths, with both surgical and anaesthetic factors at play.

There were five Category 1 deaths associated with anaesthetic factors.

- These consisted of two aspiration events, two cardiovascular collapses (one post induction; one after insertion of paravertebral block), and one bronchospasm event.
- Patient ages ranged from 62 to 75 years, with four of the cases being emergencies and one urgent.
- All anaesthetists were graded as specialists.

Figure 8 below, shows the distribution of the hospital levels by the classification categories for cases reviewed in 2021.

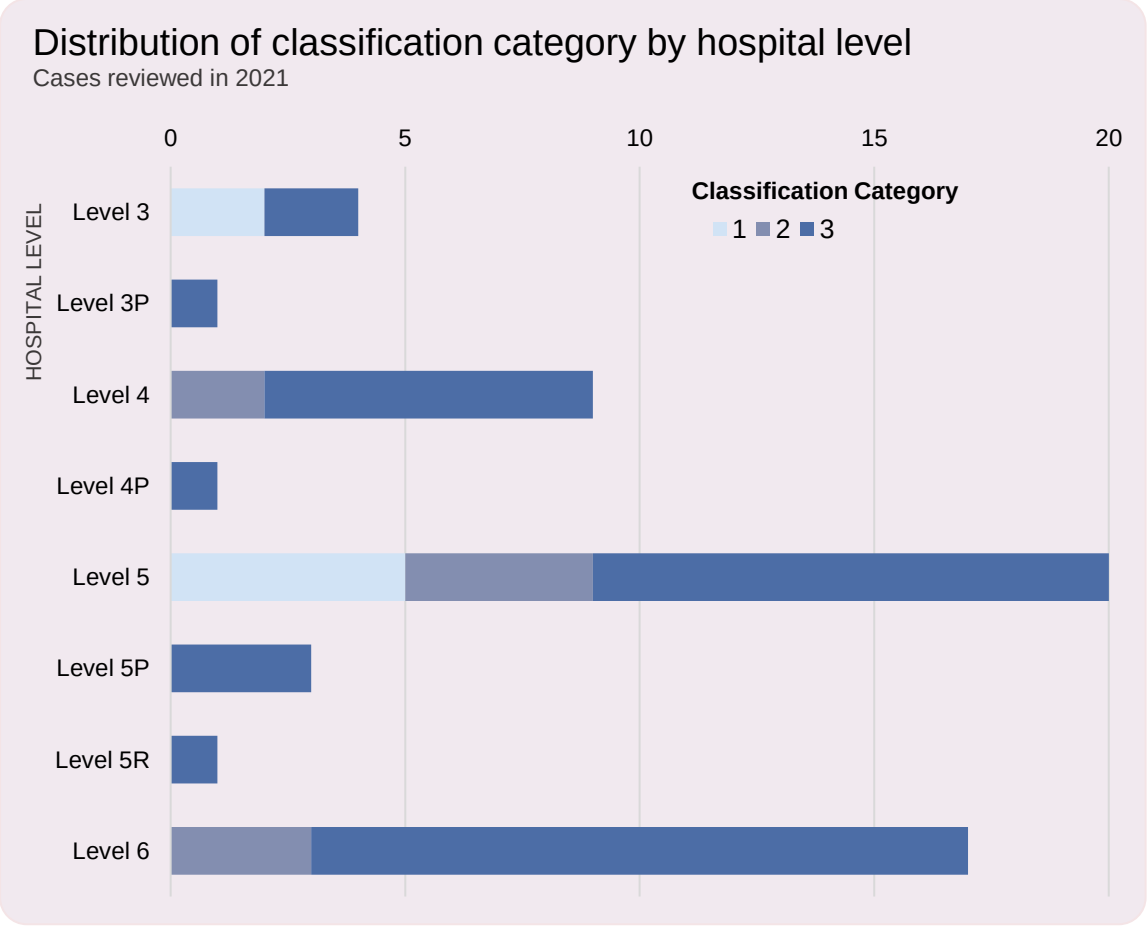

Figure 8: Distribution of anaesthesia-related deaths by hospital type for 2021 (n=56).

Causal or contributory factors

Of the 56 cases classified as anaesthesia-related, 41 cases (74.21%) had no causal or contributory factors identified. The remaining 15 cases (26.79%) noted causal or contributory factors. Anaesthetic technique was the most frequent (n=9), being related to airway maintenance and one ventilation-related factor.

Of the 15 anaesthesia-related deaths with correctable factors, 40% (n=6) were classified as Category 1 deaths, and 73.3% (n=11) of patients were aged 65 or older. Table 3 lists the causal or contributory factors for the anaesthesia-related cases reviewed in 2021.

Causal or contributory factors	Frequency count
A Pre-Operative	**6**
Ai Assessment	6
Aii Management	0
B Anaesthetic technique	**9**
Bi Choice or application	0
Bii Airway maintenance	8
Biii Ventilation	1
Biv Circulatory support	0
C Anaesthesia drugs	**3**
Ci Selection	1
Cii Dosage	1
Ciii Adverse event	1
Civ Inadequate reversal	0
Cv Incomplete recovery	0
D Anaesthetic management	**2**
Di Crisis management	0
Dii Inadequate monitoring	2
Diii Equipment failure	0
Div Inadequate resuscitation	0
Dv Hypothermia	0
E Post-Operative	**2**
Ei Management	2
Eii Supervision	0
Eiii Inadequate resuscitation	0
F Organisational	**3**
Fi Inadequate supervision or assistance	1
Fii Poor organisation	0
Fiii Poor planning	2
G No correctable factor	**41**
H Medical condition of patient a significant factor	**52**

Table 3: Factors identified in anaesthesia-related deaths, 2021 (n=56).

Note: Some anaesthesia deaths have more than one causal or contributing factor identified.

Distribution of urgency

The committee classifies the timing of surgery into the four categories as listed below in Table 4:

Emergency	Immediate surgery for a life-threatening condition (less than 30 minutes), e.g., ruptured abdominal aortic aneurysm, intracranial extra-dural haematoma, prolapsed umbilical cord.
Urgent	At the earliest available time to prevent physiological deterioration (30 minutes - 4 hours), e.g., ruptured viscus, appendicitis, open wound, blocked ventriculo-peritoneal shunt.
Urgent non-emergency	The patient has a condition that requires emergency surgery, but there is time to allow medical optimisation and appropriate organisation of operating time and surgeons or surgical teams (4 hours to days), e.g., fractured neck of femur, pacemaker insertion, laparotomy for bowel obstruction.
Scheduled	Where the patient presents for elective surgery.

Table 4: Definition of operating theatre timing schedules.

Almost half of the anaesthesia-related deaths were scheduled as urgent non-emergency at 46.43% (n-26). A third of the deaths were emergency cases at 32.14% (n=18); and the remaining 21.43% of cases (n=12) represent scheduled surgery. Of the 18 emergency cases, there were seven orthopaedic cases. Six of the 18 patients died in the operating theatre (2 orthopaedic; 2 endoscopy, and 2 'other' – abandoned procedures). Figure 9 shows the theatre urgency distribution for anaesthesia-related deaths reviewed in 2021.

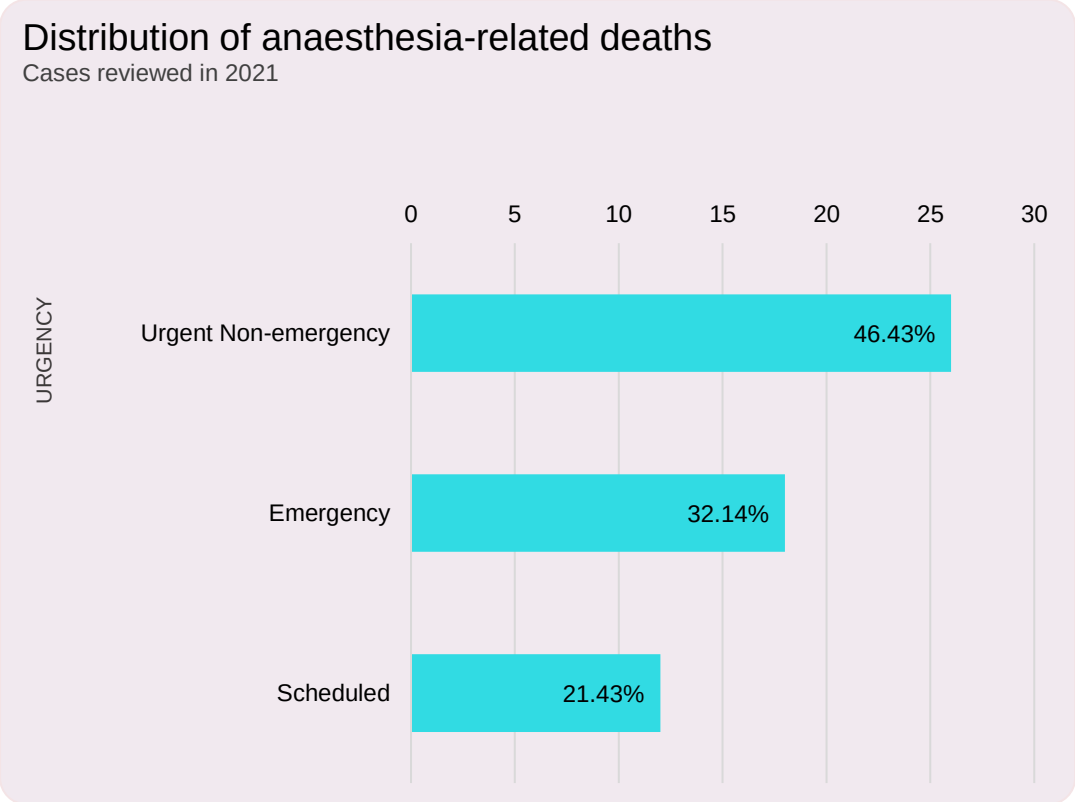

Figure 9: Distribution of urgency for anaesthesia-related deaths 2021.

Age and gender of patients

Age and gender distribution for anaesthesia-related deaths in 2021 are shown below in Figure 10. Males represented 53.57% (n=30) and females 46.43% (N=26), with the median age 75 and 84 respectively. The highest age band range is 80-84 years (n=12), followed by 90-94 years (n=10).

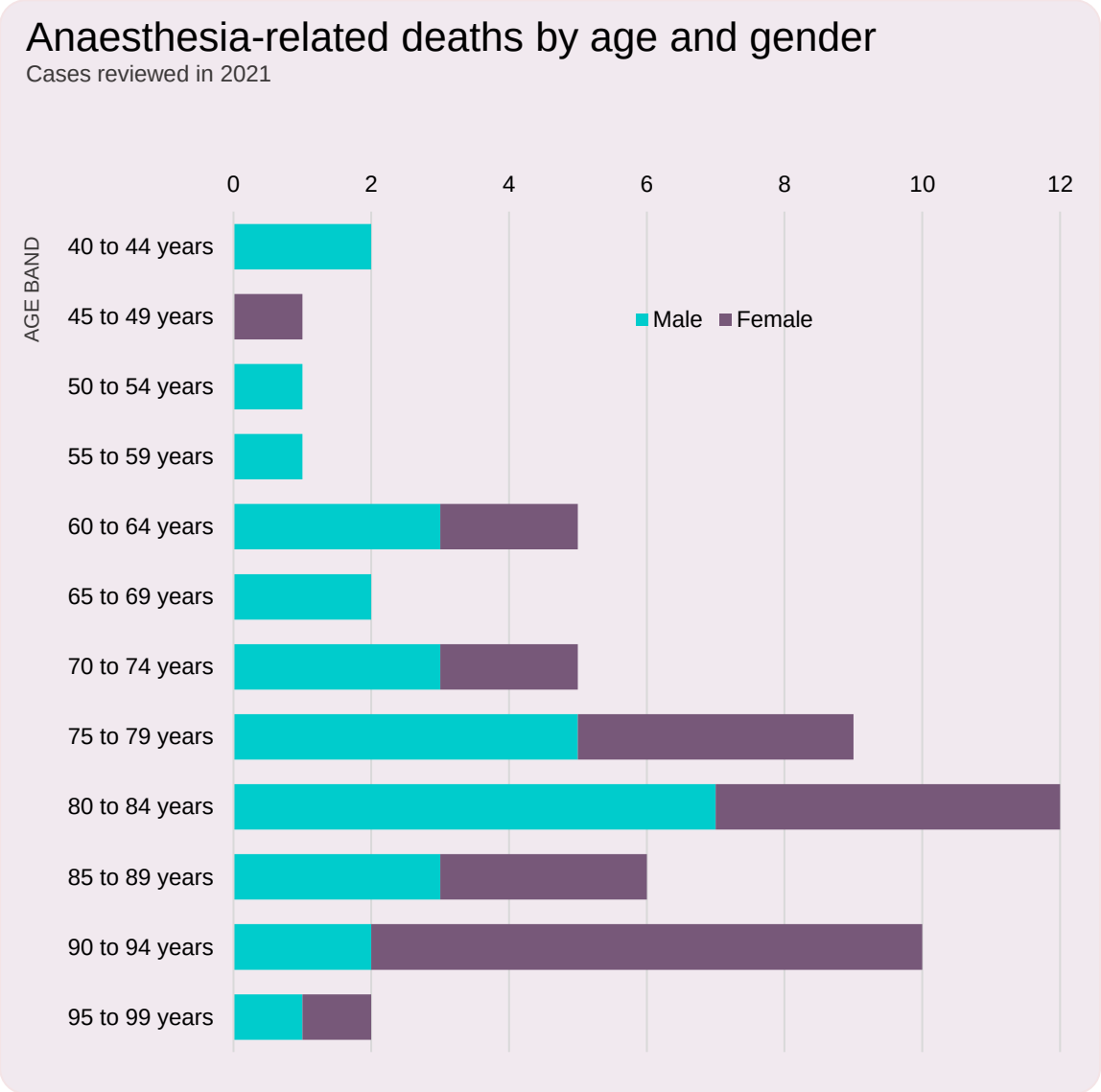

Figure 10: Distribution of age and gender for anaesthesia-related deaths 2021.

ASA grade

The American Society of Anaesthesiologists (ASA) Physical Status Classification System has been in use for over 60 years to assess and grade patients according to their pre-anaesthesia health to assist with predicting peri-operative risk factors.

Review of the anaesthesia-related deaths in 2021 shows that the 64.28% of deaths occurred in patients aged 75 or over, and the ASA 3 grade was represented at 14 deaths and ASA 4 at 22 deaths. There was one ASA 2 anaesthesia-related death associated with aspiration. There were three ASA 5 anaesthesia-related deaths; two patients with fractured neck of femur and the other with an obstructed airway (foreign object). Figure 11 shows the age band distribution against the assigned ASA status for anaesthesia-related deaths reviewed in 2021.

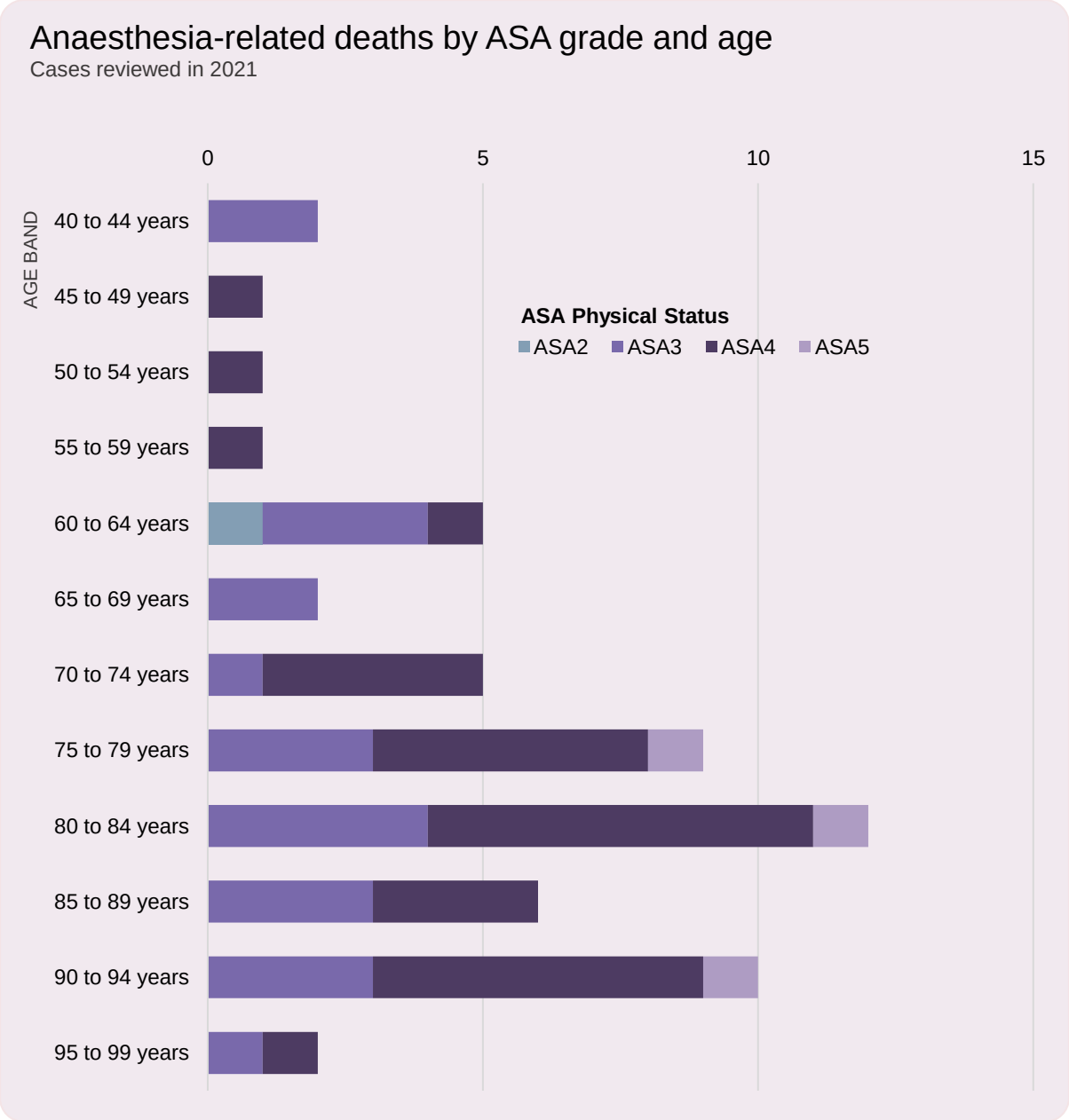

Figure 11: Distribution of ASA grade for anaesthesia-related deaths 2021.

Category 5: Inevitable deaths

Despite intervention, some deaths are inevitable due to the severity of the patient's condition. The majority of cases reviewed in 2021, 70.26% (n=215), were classified as having no anaesthetic or surgical factors and were seen as inevitable deaths. The main ASA grades associated are ASA 4 at 41.66% (n=90) and ASA 5 at 49.30% (n=106). Trauma was associated in 10.23% (n=22) of these cases reviewed.

Most inevitable deaths occurred following an operation or procedure in the following specialties as shown in Figure 12. Abdominal procedures are the most frequent intervention at 30.23% (n=65). Figure 12 shows the surgical specialty distribution for deaths classified as inevitable in 2021.

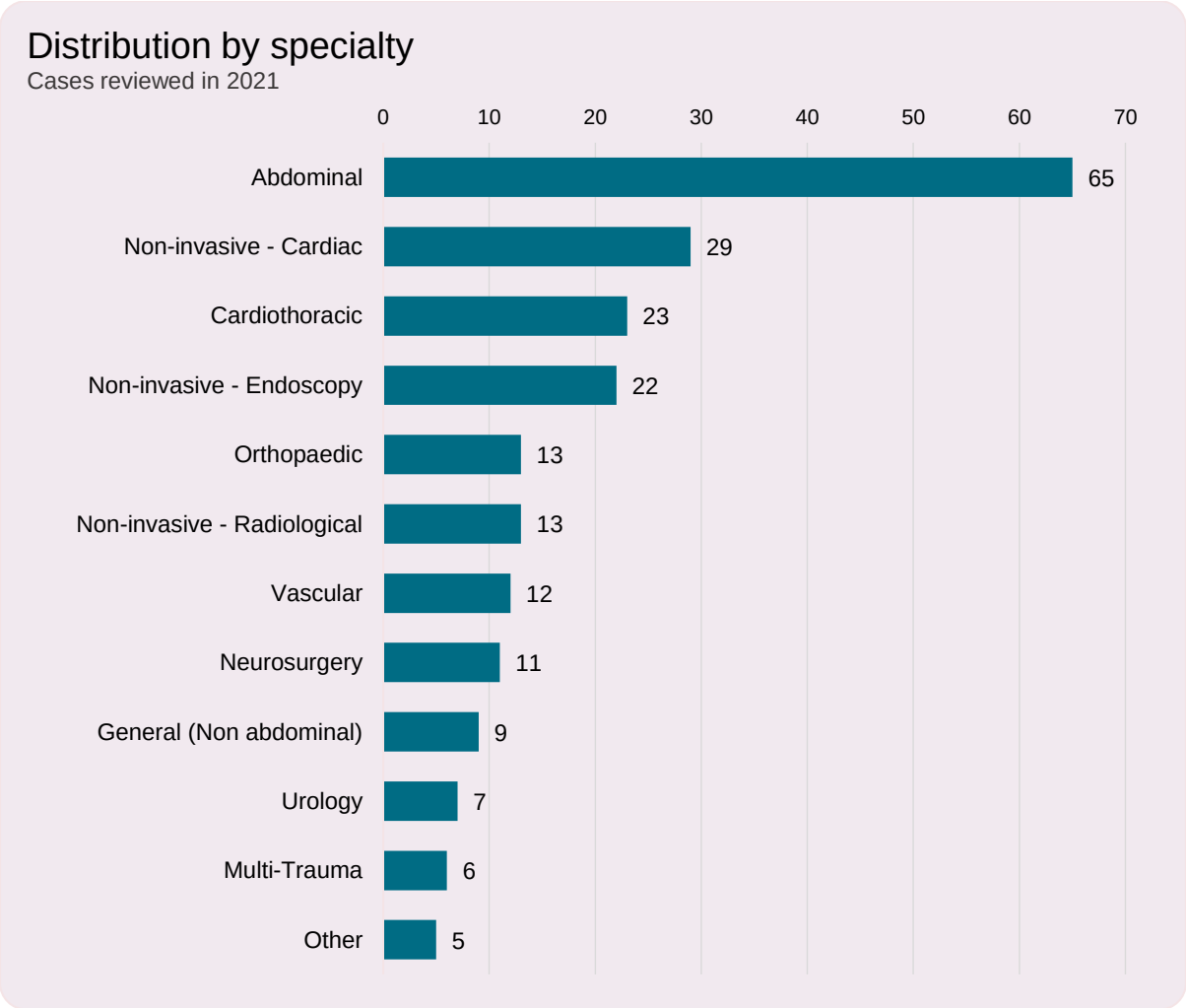

Figure 12: Specialty distribution for inevitable deaths as determined by SCIDUA 2021.

Additional Data

Trends for deaths occurring 2017-2021

1: Deaths notified to SCIDUA

There was a reduction in 2021, similar to the previous year, in the number of notifications of death to SCIDUA, A total of 1,625 deaths were reported to SCIDUA in the five-year period 2017 to 2021. The peak year for notification remains 2017 at 395 (although it is previously noted that 9.39% of forms were either incomplete forms or excluded.

Over the five-year reporting period 2017-2021, 14.64% (n=238) of deaths notified to SCIDUA were assessed as being attributable to anaesthesia. The majority of notifications were for deaths in which anaesthesia played no part at 79.26% (n=1,288). The remaining 6.09% (n=99) represent the un-assessable or excluded cases.

The following figures over the next pages show trends for the five-year period, 2017-2021, as indicated.

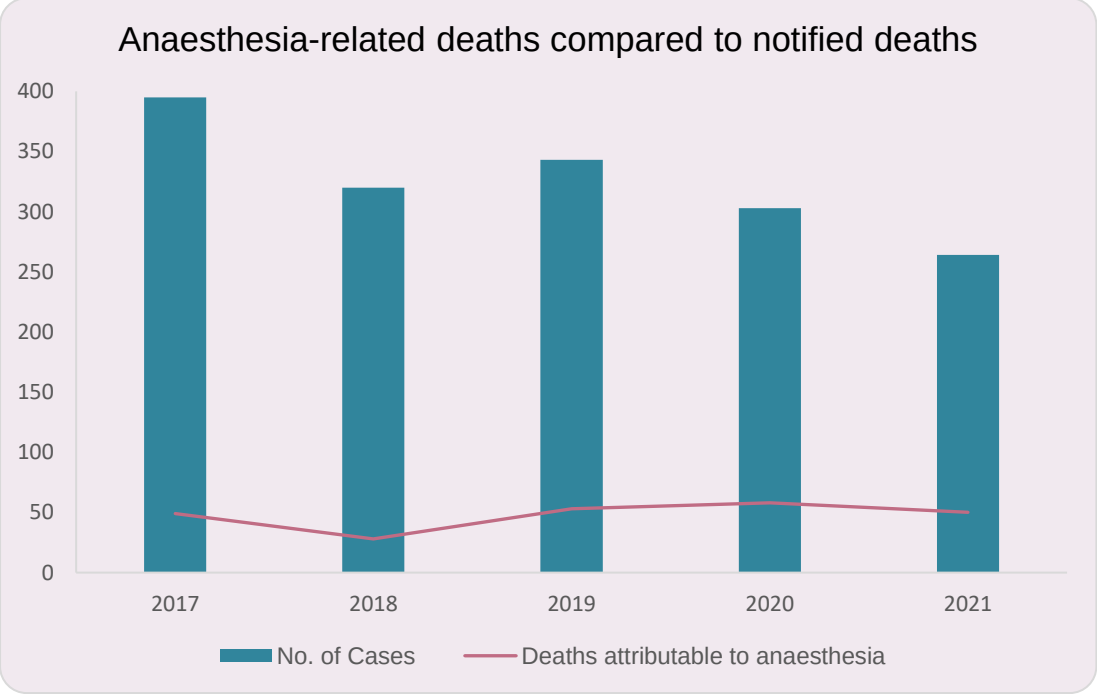

Figure 13: Comparison of anaesthesia-related deaths to notification of deaths, 2017-2021.

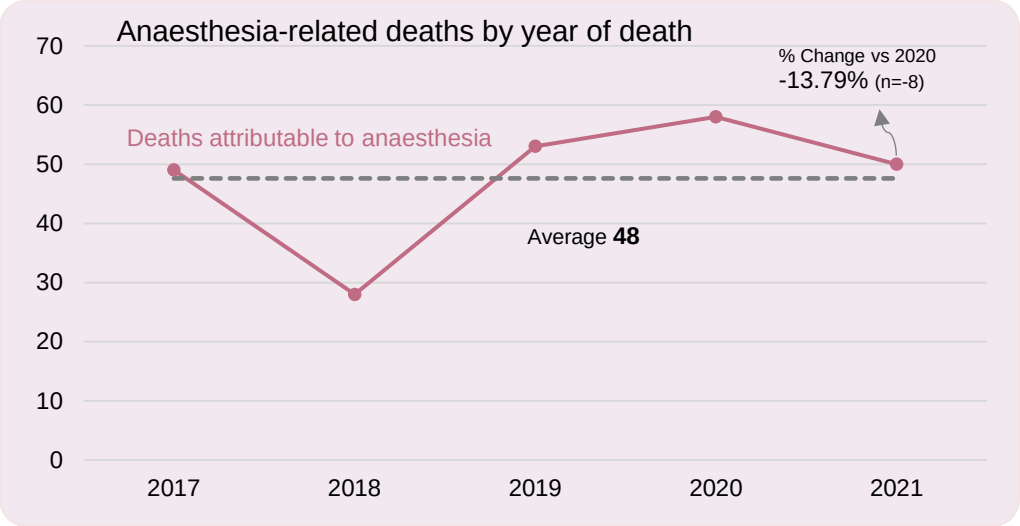

Figure 14: Anaesthesia-related deaths, 2017-2021.

2: Age and gender of patients

Age and gender charts for anaesthesia-related deaths as indicated below.

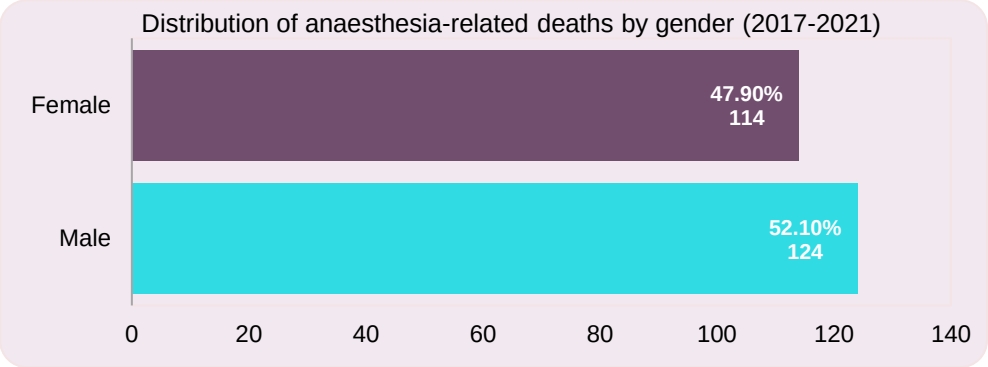

Figure 15: Distribution of anaesthesia-related deaths by gender, 2017-2021.

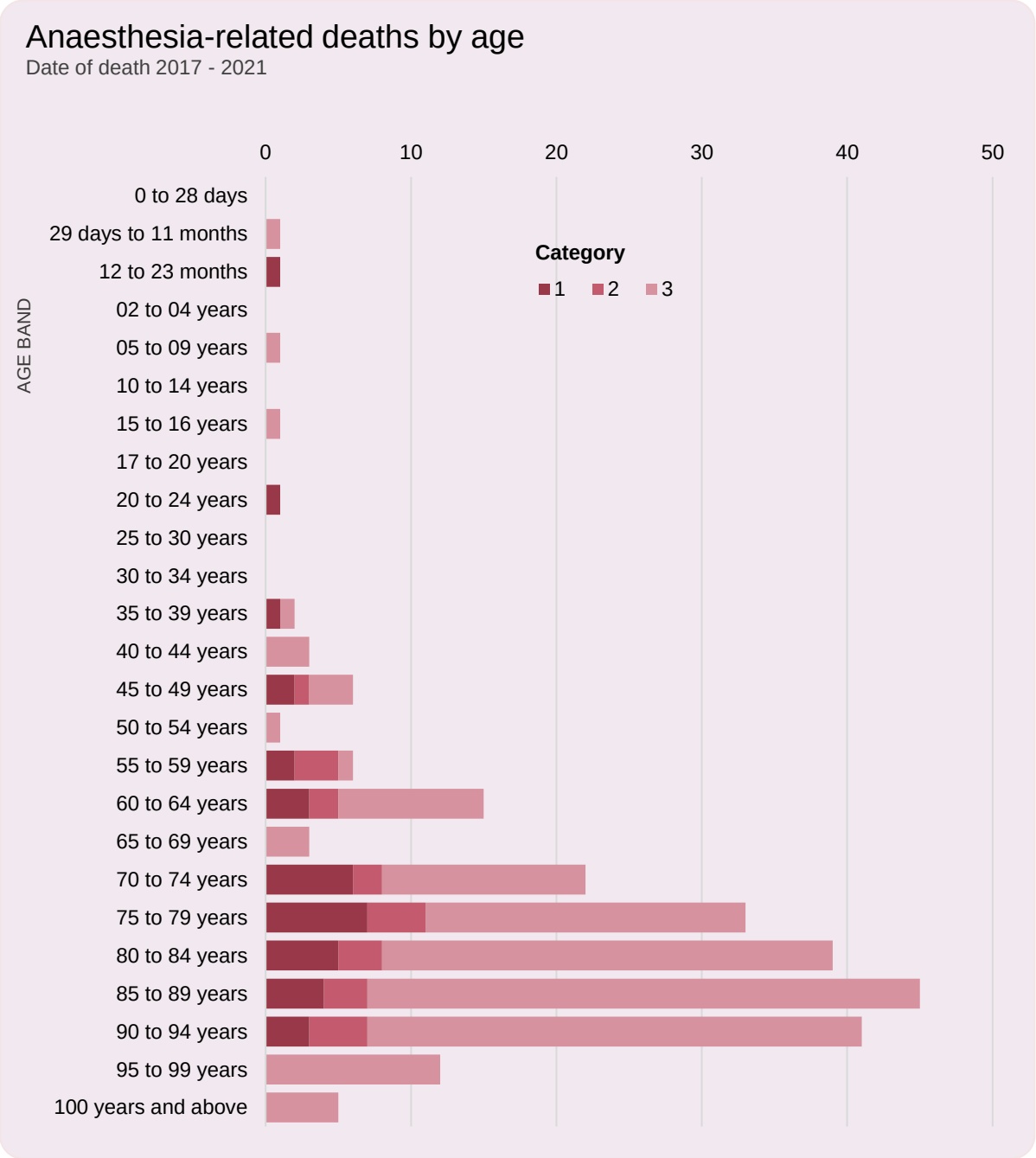

Figure 16: Anaesthesia-related deaths age ranges, 2017-2021.

3: Notification and submission timelines

The response rate for anaesthetists is calculated using the patient date of death and the date the Form of Notification (State Form) is submitted to SCIDUA. The introduction of electronic forms in 2020 has enabled same day reporting, of which there were 11 in 2021.

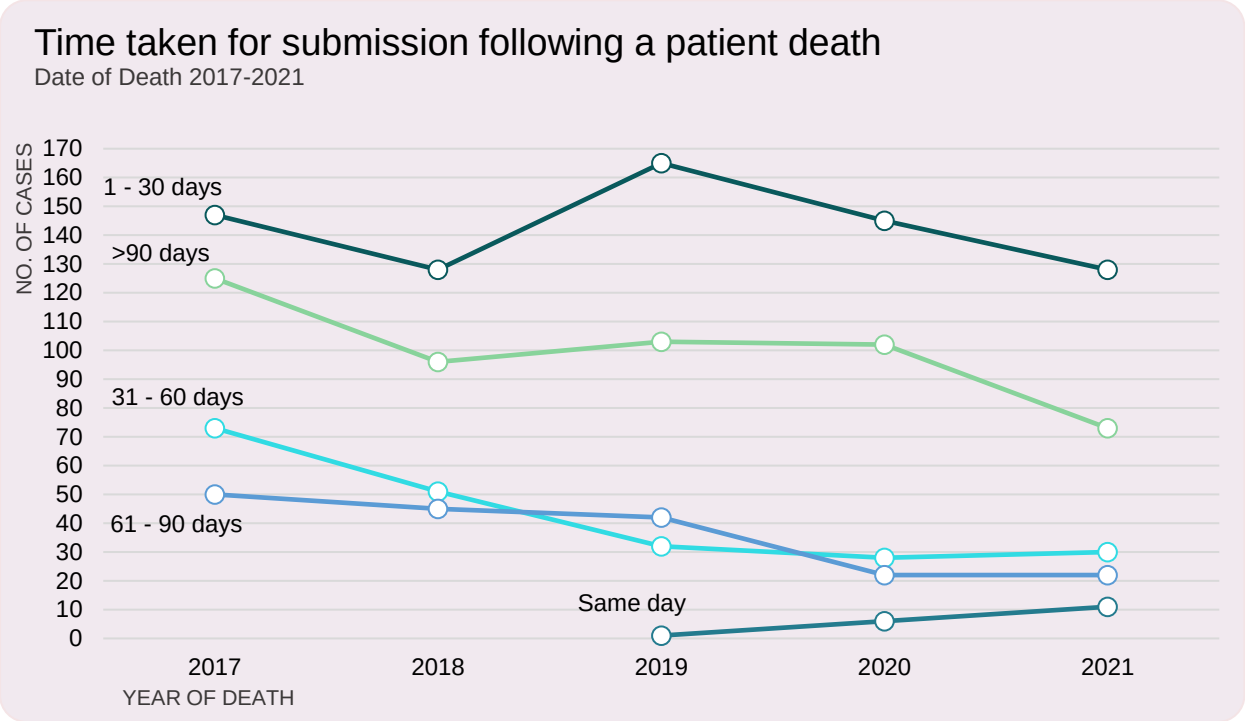

Figure 17: Days taken to submit a notification form to SCIDUA following a death, 2017-2021.

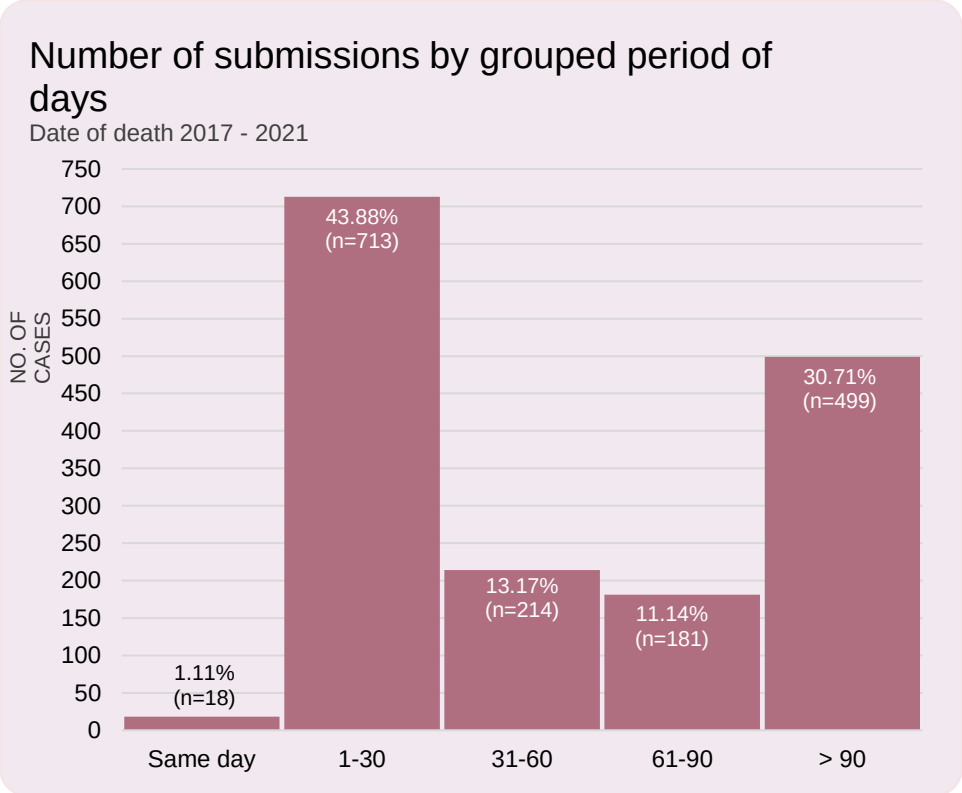

Figure 18: Number of forms submitted by grouped periods of days, 2017-2021.

4: Distribution of deaths for public and private hospitals

There were 82 hospitals participating in SCIDUA for the period 2017-2021. This was a mix of public and private facilities with distribution shown in the charts below.

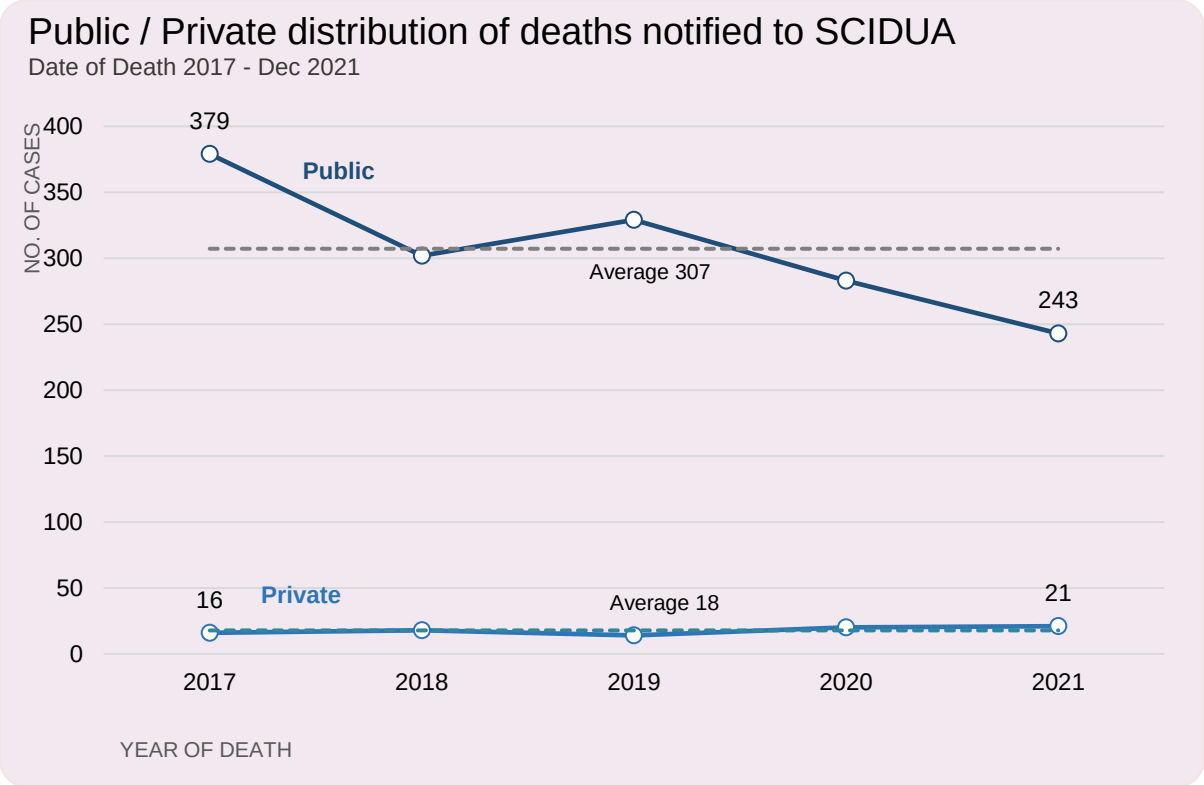

Figure 19: Comparison of public and private hospital notifications, 2017-2021.

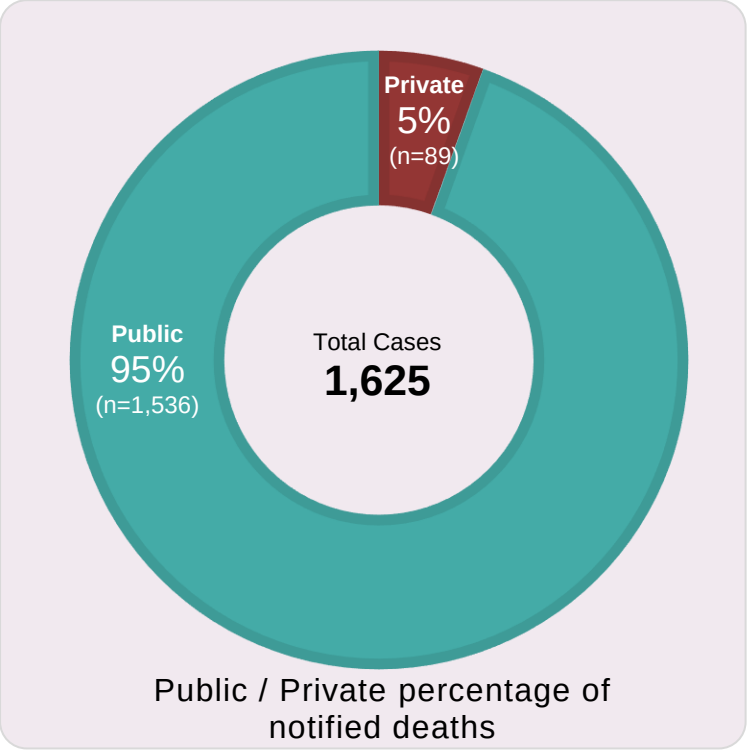

Figure 20: Comparison of public and private hospital notifications by percentage, 2017-2021.

5: Sedation deaths

These are deaths which occurred whilst under sedation and are usually day-only admissions for gastroenterology, cardiology or intensivist procedures.

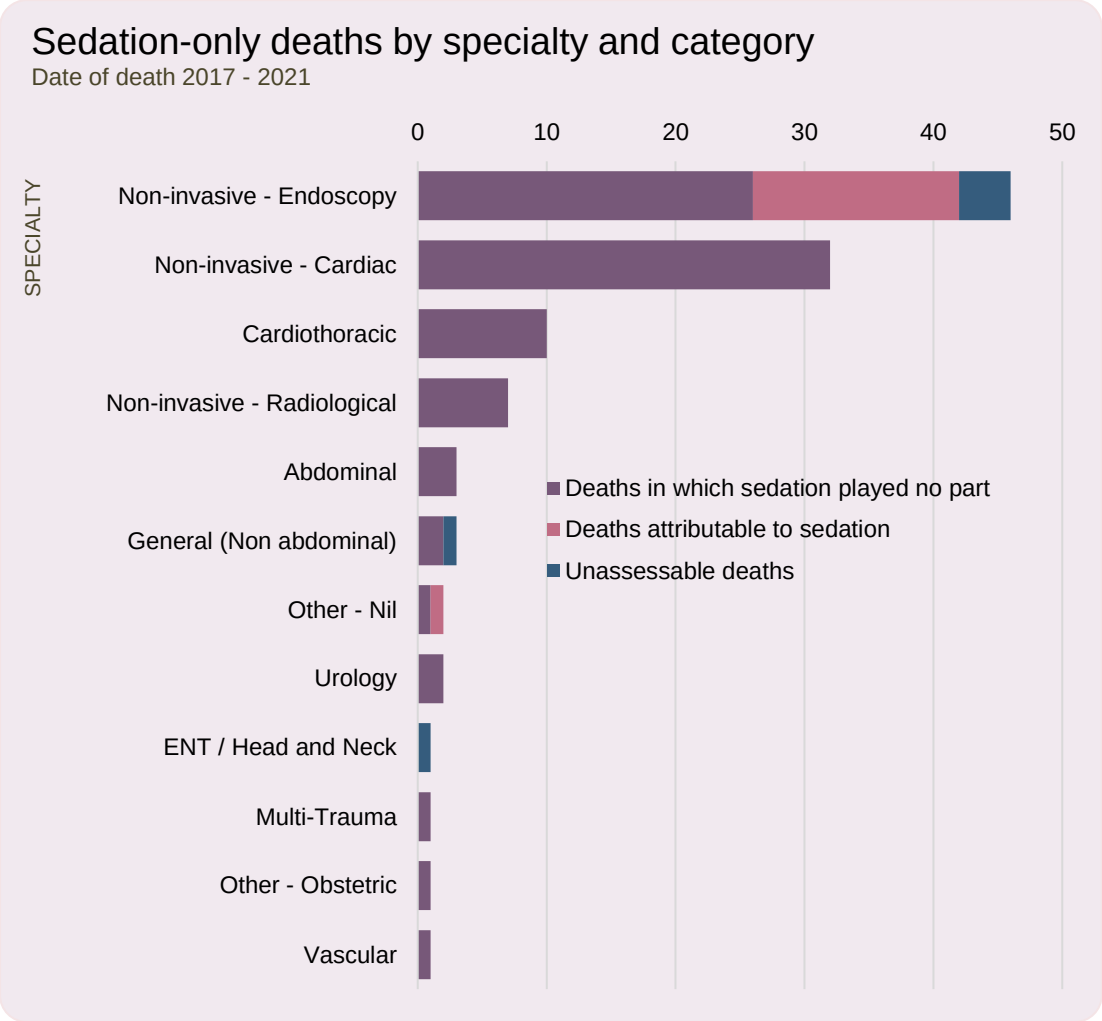

Figure 21: Sedation-only deaths by specialty and category, 2017-2021.

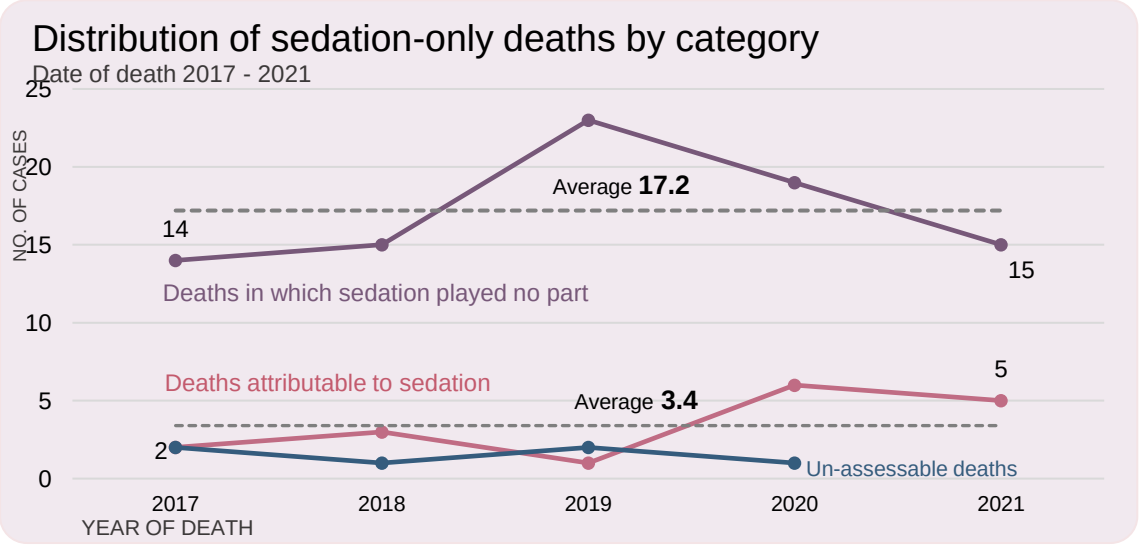

Figure 22: Distribution of sedation-only deaths by category, 2017-2021.

6: Causal and contributing factors

Of the 238 anaesthesia-related deaths investigated by SCIDUA for the reporting period, 66 cases (27.73%) had a total of 109 correctable factors identified. The highest representation was expressed in Group B – Anaesthesia technique (n=43); with "airway maintenance" being the highest cause of death.

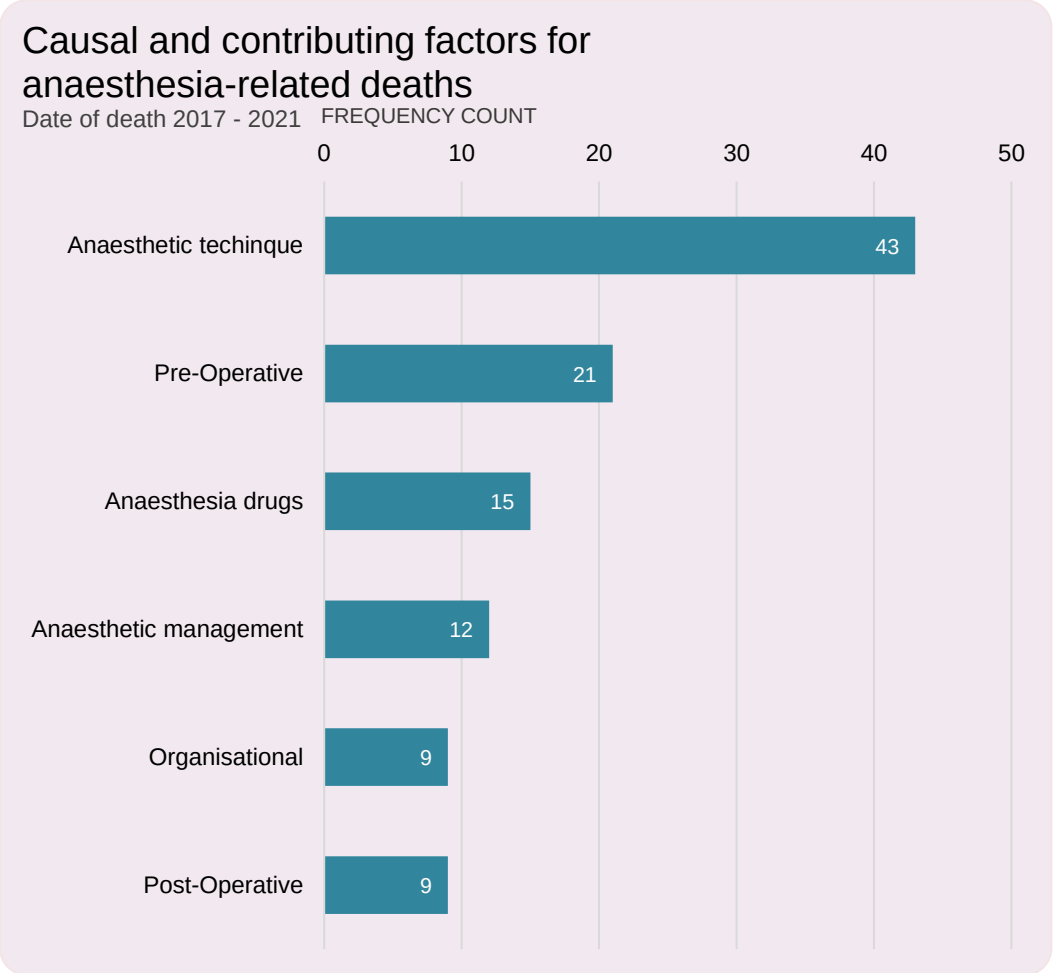

Figure 23: Causal and contributing factors in anaesthesia-related deaths, 2017-2021.

Adverse reaction to anaesthesia

The Committee identified 8 deaths where the patient had an adverse event to the anaesthesia drugs administered to them. The 5 males who died were aged between 55 and 76 years of age, and the 3 females were aged between 36 and 72.

The distribution for location of death was ICU/HDU (n=4); Operating Theatre (n=3); and Recovery Room (n=1). Of the 8 deaths, 5 were scheduled admissions with 2 deaths occurring in private hospitals.

Bone cement implantation syndrome

SCIDUA classified 38 deaths where bone cement was considered the cause of death.[3]

All deaths were classified as Category 3 - *Where death was caused by both surgical and anaesthesia factors.*

Physical status pre-operatively for all patients was classified as ASA grade 3 (n=16) and ASA grade 4 (n=22).

36 deaths (94.74%) were for orthopaedic surgery, of these:

- Ages ranged from 61 – 101 years
- Average age 82.24 years
- Gender ratio: Female = 29; Male = 7

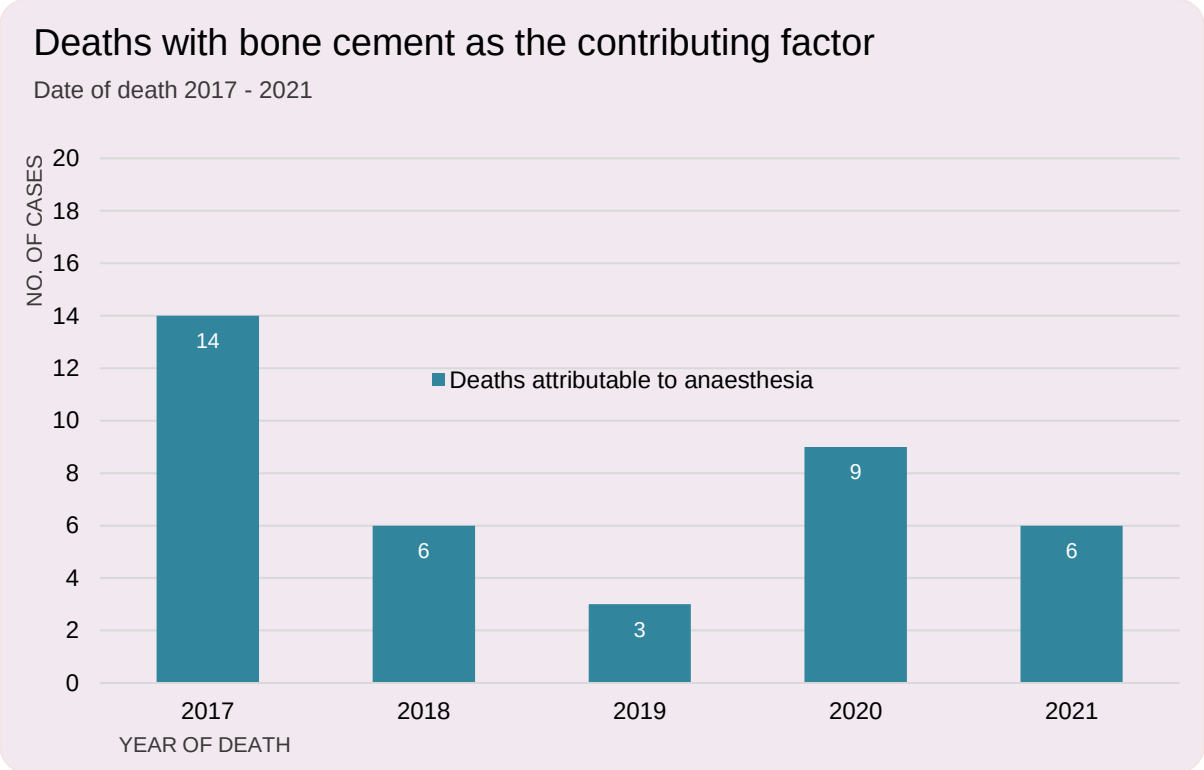

Figure 24: Deaths with bone cement contributing factor, 2017-2021.

[3] The impact of cement fixation on early mortality in arthroplasty for hip fracture, N. Ramsay, J.C.T. Close, I.A. Harris, L.A. Harvey, UNSW Medicine and Health, Sydney, Bone Jt Open 2023;4-3:198–204. 2633-1462.43.BJO-2023-0006.R1.pdf

7: Grade of anaesthetist

Grade of anaesthetist for anaesthesia-related deaths is explored in the figures below.

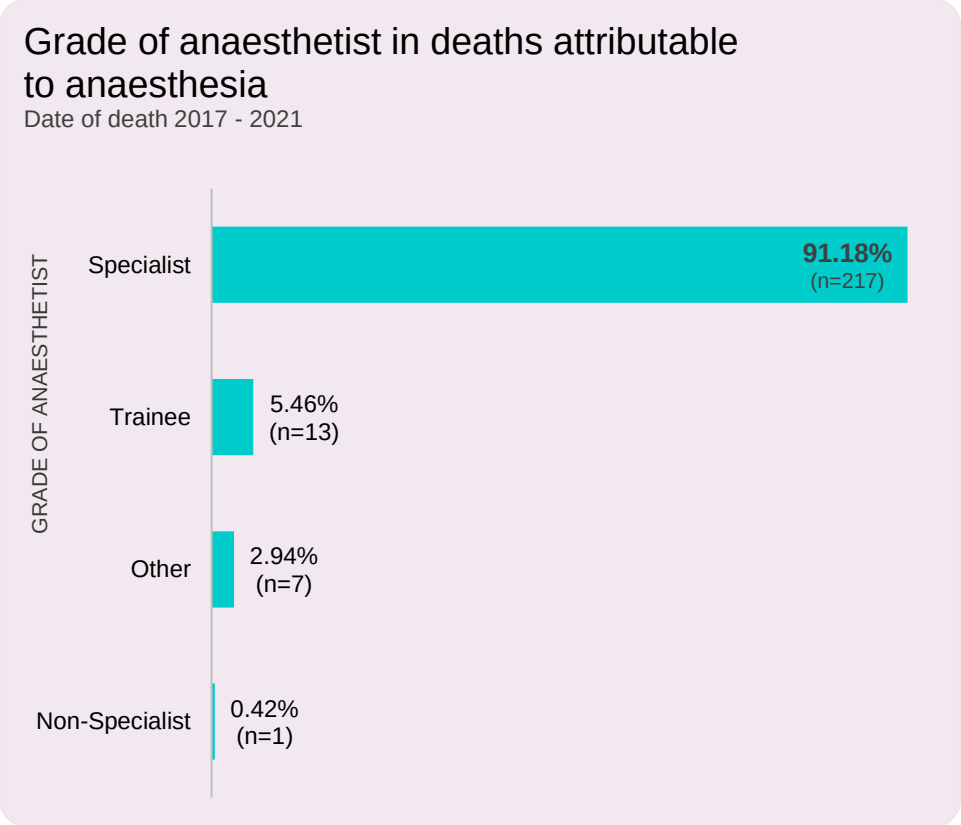

Figure 25: Grade of anaesthetist in deaths attributable to anaesthesia, 2017-2021.

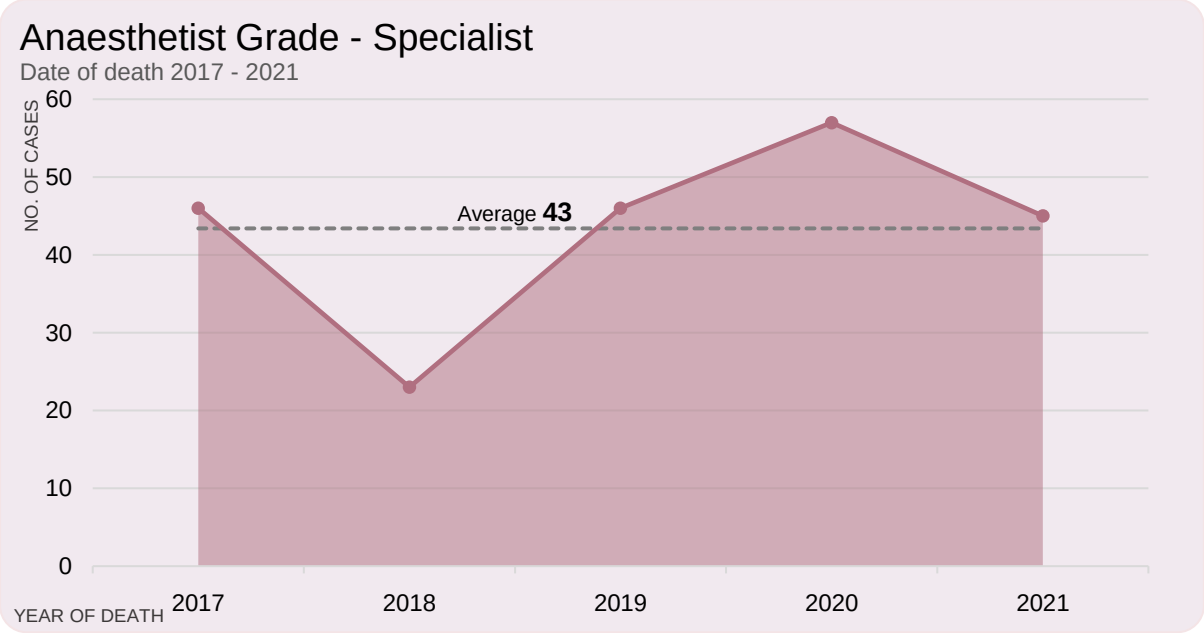

Figure 26: Specialist anaesthetist grade, anaesthesia-related deaths, 2017-2021.

8: Location of death

The most common hospital location for all deaths reviewed by SCIDUA is the intensive Care Unit / High Dependency Unit (ICU/HDU), representing 65.21% (n=1,018) of deaths for the reporting period. Of the deaths deemed anaesthesia-related that occurred in ICU/HDU, ASA 4 was the most frequent score with 55 patients – Figure 27.

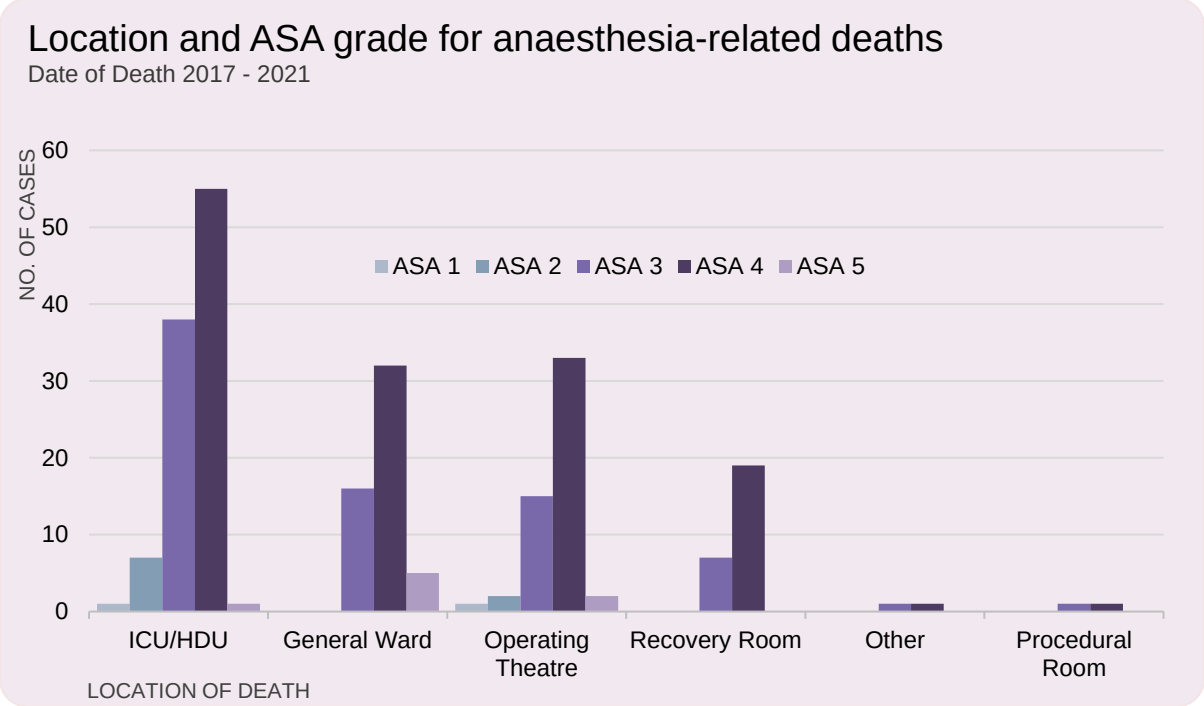

Figure 27: Death location and ASA grade for anaesthesia-related deaths, 2017-2021.

There was an average of 11 anaesthesia-related deaths per year occurring in the operating theatre and procedural room location over the five-year period 2017-2021, as shown in Figure 28 below.

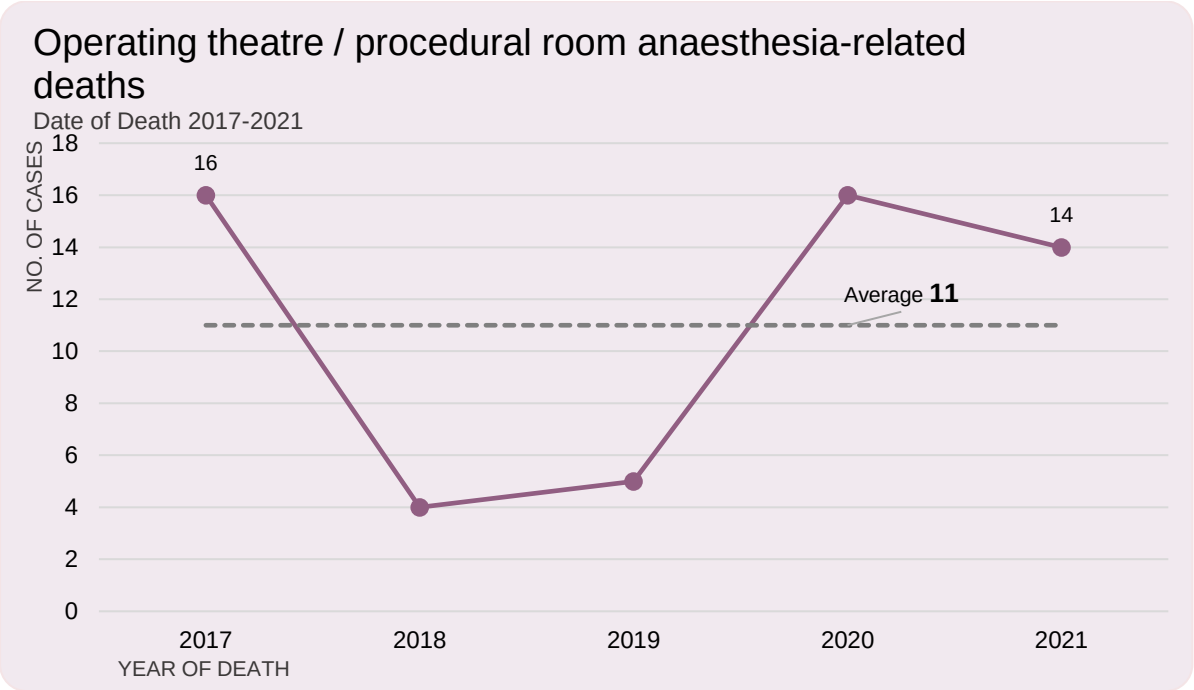

Figure 28: Operating theatre and procedural room anaesthesia-related deaths, 2017-2021.

9: Hospital level and type

The highest Category 1 deaths (n=16) for the reporting period occurred in Level 5 Public Hospitals. Trends for Level 5 and 6 hospitals are shown in Figure 29, below.

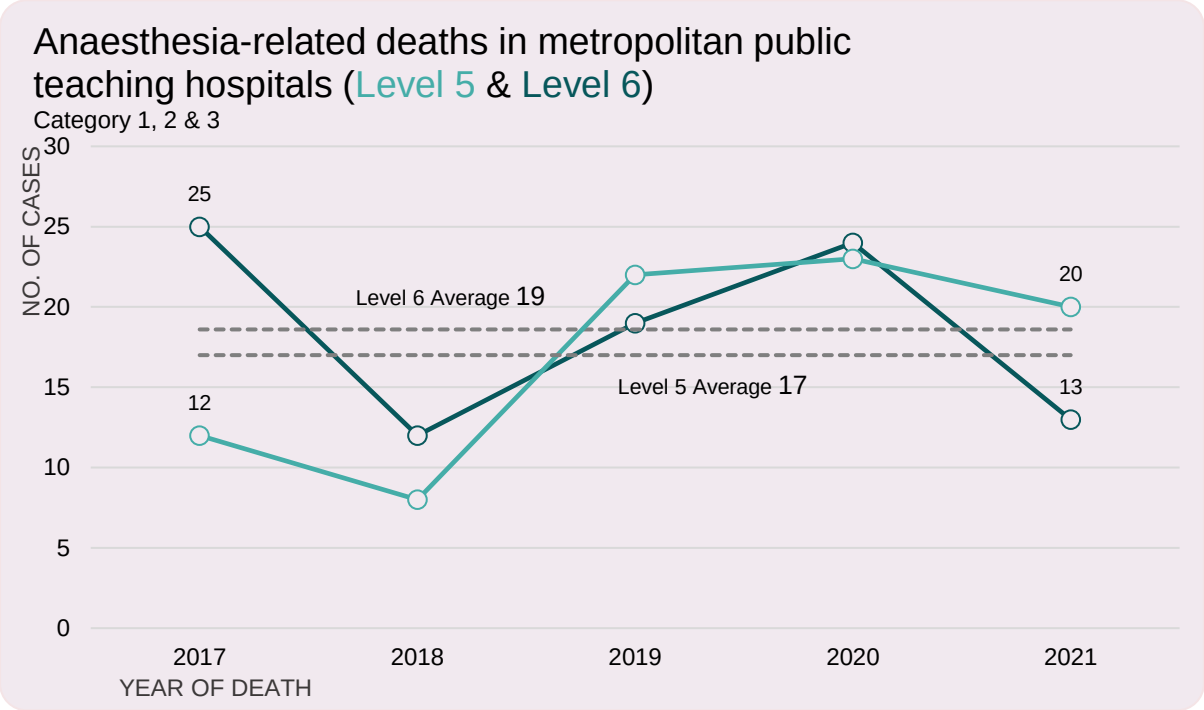

Figure 29: Metropolitan public teaching hospital anaesthetic-related deaths, 2017-2021.

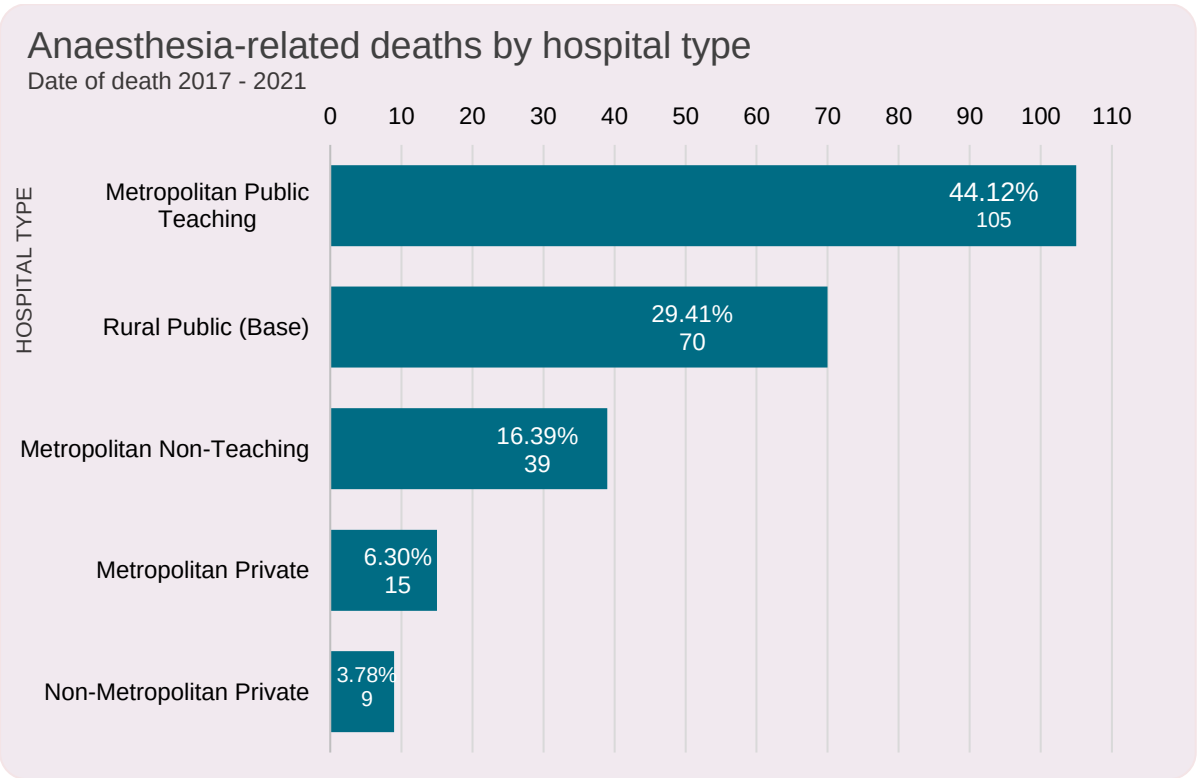

Figure 30: Anaesthesia-related deaths by hospital type, 2017-2021.

10: Time of death

Analysis on the time when anaesthesia-related deaths occur is shown in Figure 31. Hourly intervals show the number of deaths, with the highest representation for 19:00-19:59 hours (n=17), followed by 18:00-18:59 hours and 16:00-16:59 hours (both with 16 deaths).

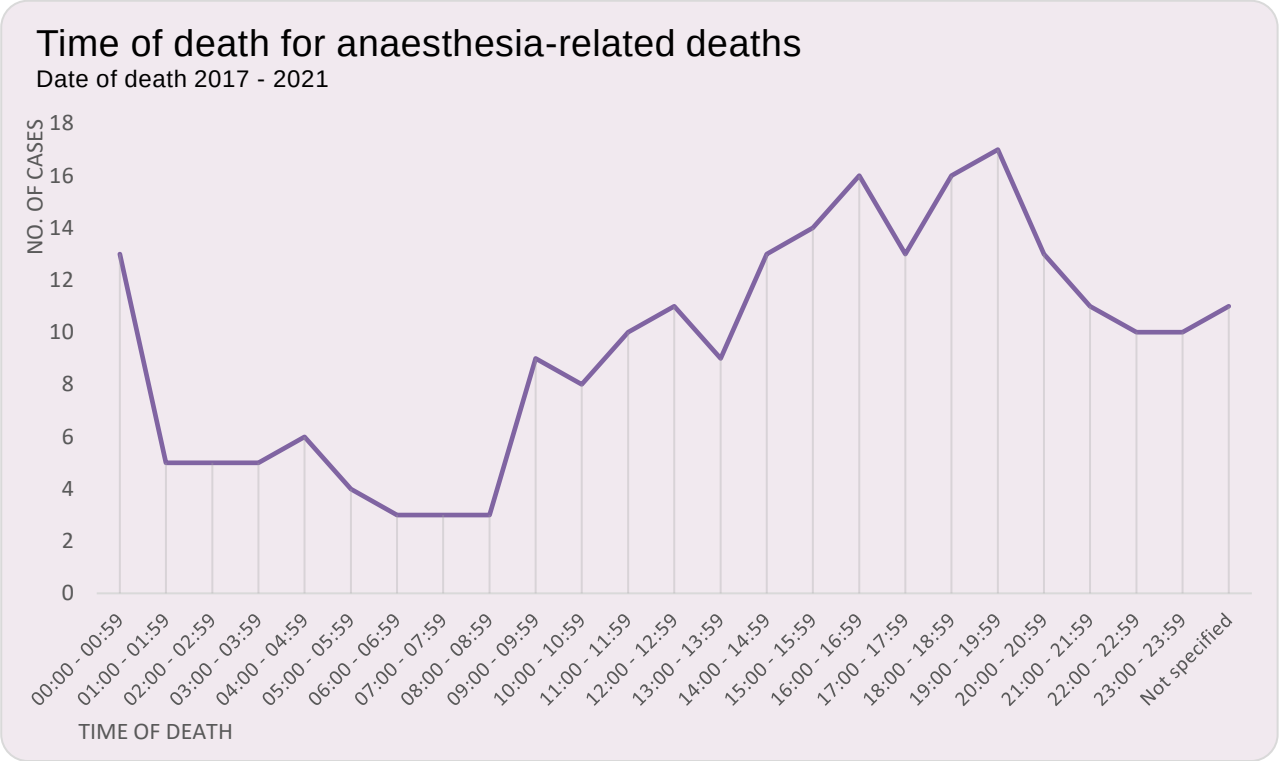

Figure 31: Time of death for anaesthesia-related deaths, 2017-2021.

11: ASA grade

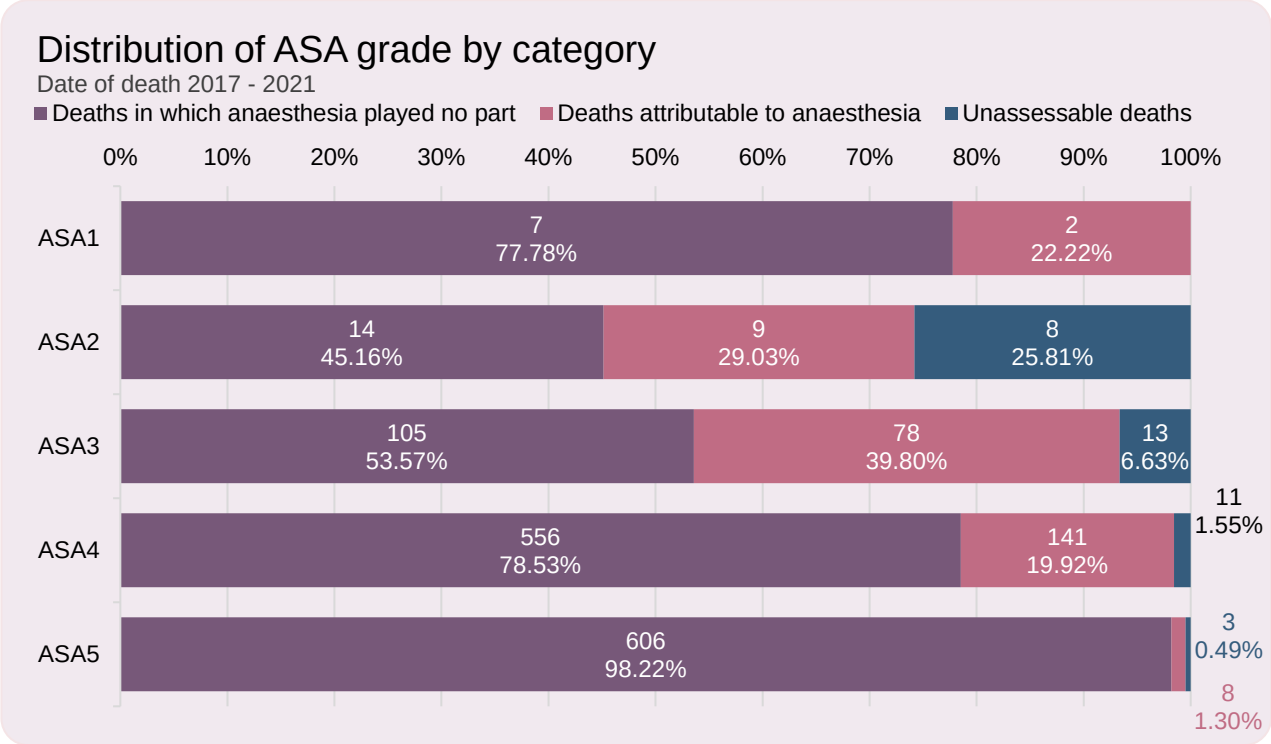

Figure 32: Distribution of ASA grade by category, 2017-2021.

12: Trauma deaths

The highest representations for the reporting period for trauma deaths are:

- Orthopaedic surgical admissions (n=163)
- Hospital Level 6 admissions (n=131)
- Female deaths (n=127)
- ASA 4 classification (n=126)
- ICU/HDU location of death (n=116)
- Inevitable trauma deaths (n=114)
- Trauma deaths in 2019 (n=63)

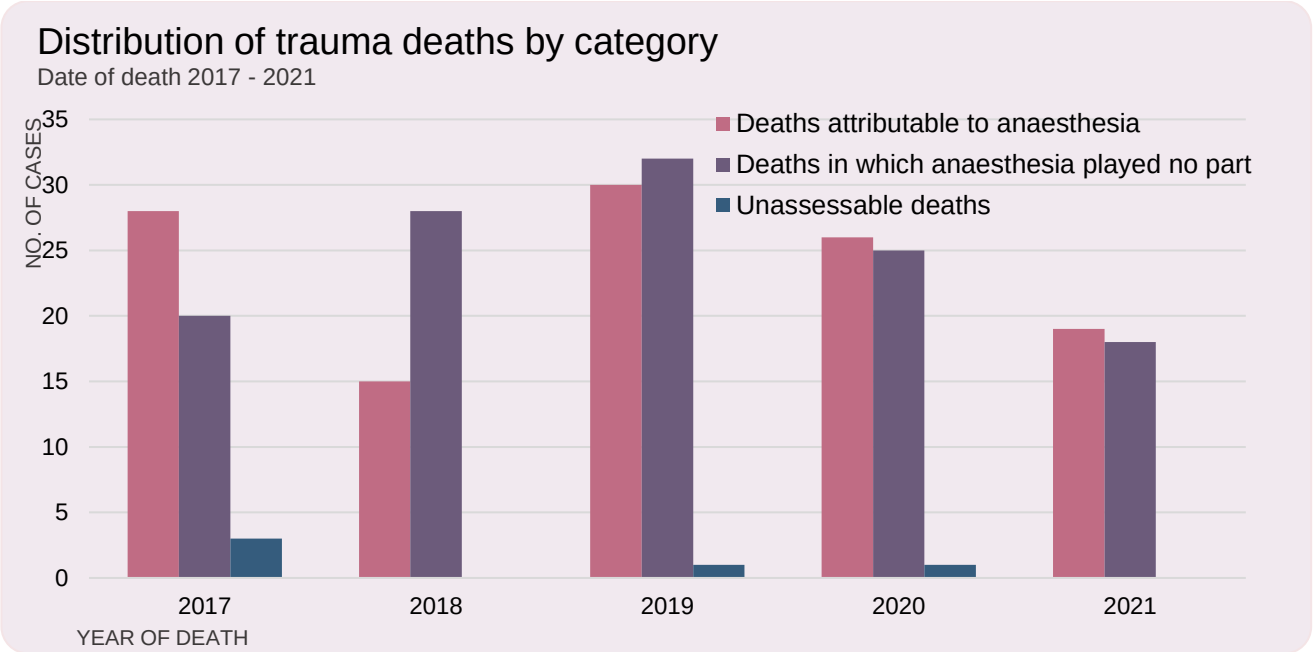

Figure 33: Distribution of trauma deaths by category, 2017-2021.

13: Futile surgery

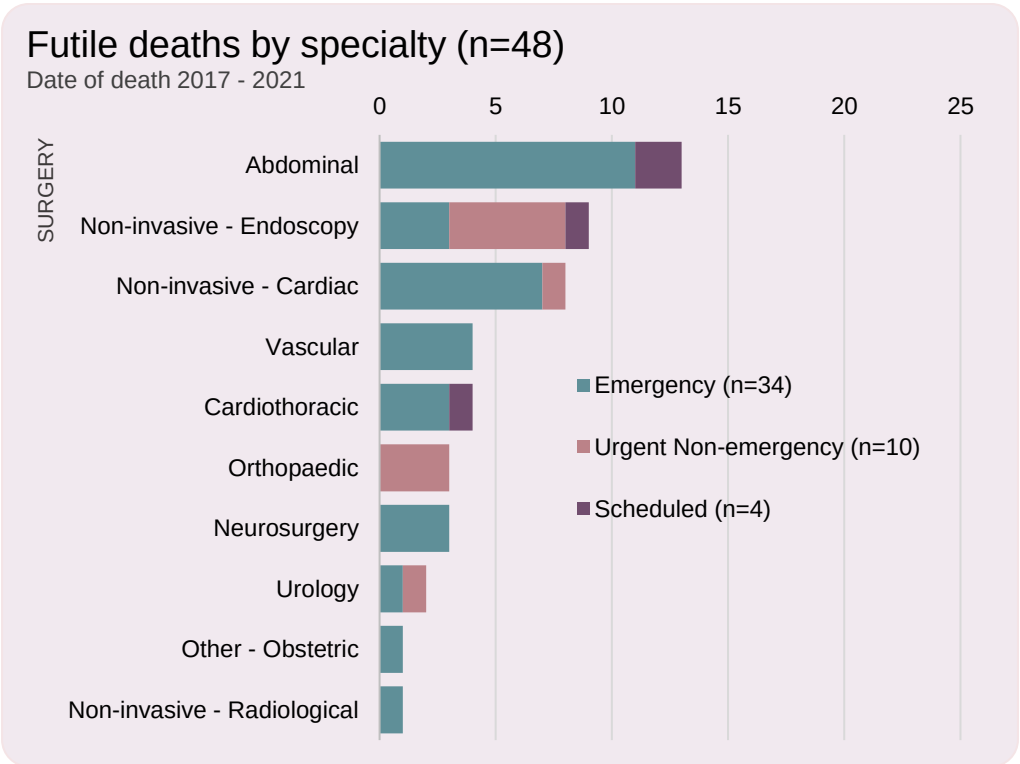

Figure 34: Futile deaths by specialty, 2017-2021.

14: Inevitable and un-assessable deaths

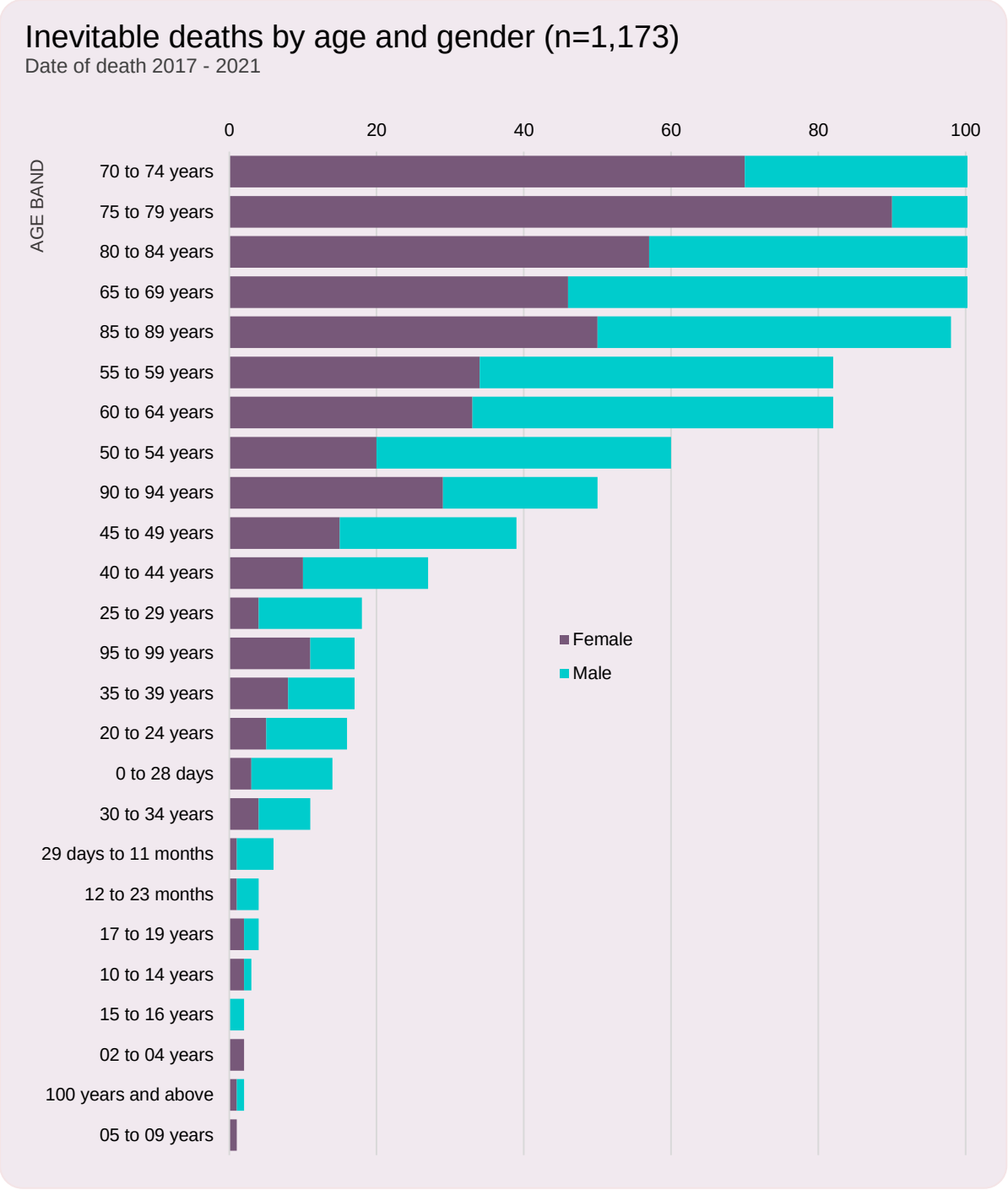

Figure 35: Inevitable deaths by age and gender, 2017-2021.

Un-assessable deaths

These are notifications where despite all efforts to gain information to support classification, the Committee was unable to define a category for the death.

The lowest representation of un-assessable deaths was in 2021 (n=2). Analysis shows a downward trend since 2017 (n=14) with the decrease supporting the introduction of electronic forms and submissions in 2020. This enabled anaesthetists to provide more information in their submissions to SCIDUA, particularly the inclusion of ECG charts.

15: Participating Hospitals

There were 82 hospitals participating in SCIDUA for the period 2017-2021.

Albury Base Hospital	Manning Base Hospital
Armidale Rural Referral Hospital	Mater Private Hospital
Bankstown / Lidcombe Hospital	Mona Vale & District Hospital
Bateman's Bay District Hospital	Moree District Hospital
Bathurst Base Hospital	Mudgee District Hospital
Bathurst Private Hospital	Muswellbrook District Hospital
Blacktown Hospital	Nepean Hospital
Bowral & District Hospital	Newcastle Eye Hospital
Broken Hill Base Hospital	Newcastle Private Hospital
Calvary Mater Hospital (Newcastle)	North Shore Private Hospital
Calvary Private Hospital (Wagga Wagga)	Northern Beaches Hospital
Campbelltown Hospital	Norwest Private Hospital
Canterbury Hospital	Orange Base Hospital
Coffs Harbour Base Hospital	Port Macquarie Base Hospital
Concord Hospital	Prince of Wales Hospital
Coonabarabran District Hospital	Prince of Wales Private Hospital
Denman Multi-Purpose Service	Royal Hospital for Women
Dubbo Base Hospital	Royal North Shore Hospital
Fairfield & Braeside Hospitals	Royal Prince Alfred Hospital
Gosford Hospital	Ryde Hospital
Gosford Private Hospital	Shoalhaven & District Memorial Hospital
Goulburn Base Hospital	Singleton District Hospital
Grafton Base Hospital	South East Regional Hospital
Griffith Base Hospital	Southern Highlands Private Hospital
Hawkesbury District Health Service	St. George Private Hospital & Medical Centre
Hawkesbury Hospital	St. George Hospital
Hornsby & Ku-Ring-Gai Hospital	St. Vincent's Hospital (Darlinghurst)
Hurstville Community Private Hospital	St. Vincent's Private Hospital (Lismore)
John Hunter Children's Hospital	Strathfield Private Hospital
John Hunter Hospital	Sutherland Hospital
Kareena Private Hospital	Sydney Adventist Hospital
Lake Macquarie Private Hospital	Sydney Children's Hospital Randwick
Lakeview Private Hospital	Tamworth Base Hospital
Lingard Private Hospital	The Children's Hospital at Westmead
Lismore Base Hospital	The Tweed Hospital
Liverpool Hospital	Wagga Wagga Base Hospital
Macksville District Hospital	Westmead Hospital
Macquarie University Hospital	Westmead Private Hospital
Maitland Hospital	Wollongong Hospital
Maitland Private Hospital	Wollongong Private Hospital
Manly District Hospital	Wyong Hospital

Table 5: Participating hospitals, 2017-2021.