

# A practice survey of airway management in Australian and New Zealand intensive care units

Michael Toolis, Ravindranath Tiruvoipati, John Botha, Cameron Green and Ashwin Subramaniam

Airway management is a core part of intensive care medicine and consists of multiple individual components, including the assessment and planning of intubation, induction of anaesthesia, endotracheal intubation, and the anticipation and management of unforeseen complications. Following the results of the Fourth National Audit Project (NAP4) in 2011 in the United Kingdom,<sup>1</sup> it is well recognised that airway management and tracheal intubation in critically ill patients in intensive care units (ICUs) are associated with significant risk of patient harm. Complications occur in 22–54% of intubations in this setting<sup>2</sup> and range from brief periods of hypoxaemia and hypotension to cardiac arrest and hypoxic brain injury. Cardiac arrest has been reported to occur in 1.6–2.1% of intubations in ICUs in multiple retrospective studies.<sup>3–5</sup> Complications during intubations performed in the ICU result from patient factors, such as a lack of cardiovascular and respiratory reserve, and operator and situational factors relating to levels of staff training and expertise, relative urgency, device selection and equipment availability.<sup>6,7</sup> Importantly, it has been demonstrated that prolonged attempts at intubation may result in severe hypoxia, aspiration of gastric contents and even cardiorespiratory arrest and death.<sup>7</sup> It is therefore essential that the likelihood of successful first attempt tracheal intubation is maximised in critically ill patients, that complications are anticipated, and that plans for difficulty exist before commencement.

The recent *Guidelines for the management of tracheal intubation in critically ill adults*<sup>6</sup> from the British Difficult Airway Society, the Intensive Care Society, the Faculty of Intensive Care Medicine and the Royal College of Anaesthetists recommend multiple strategies to improve patient safety and outcomes during airway management in intensive care. These strategies include the use of team planning, videolaryngoscopy, intubation checklists, apnoeic oxygenation, haemodynamically stable induction agents, continuous waveform capnography, and the use of adjuncts such as bougies. Nevertheless, a recent British survey found that videolaryngoscopy, for example, was only available in 54% of ICUs.<sup>8</sup> It is currently unclear whether the strategies described in the British guidelines<sup>6</sup> are being used in ICUs in Australia and New Zealand, but a survey conducted before the publication of these guidelines revealed that

## ABSTRACT

**Objective:** To characterise intubation practices in Australian and New Zealand intensive care units (ICUs) and investigate clinician support for establishing airway management guidelines in Australian and New Zealand ICUs.

**Design:** An online survey was designed, piloted and distributed to members of the mailing list of the Australian and New Zealand Intensive Care Society (ANZICS), with medical members invited to participate. Respondents were excluded if their primary practice was in paediatric ICUs.

**Main outcome measures:** Data collected included the respondents' demographics and airway management practices and whether respondents supported the formulation of Australian and New Zealand intubation guidelines for critically ill patients in ICU and mandatory airway management training for Fellows of the College of Intensive Care Medicine of Australia and New Zealand (CICM).

**Results:** Over a quarter of ANZICS medical members completed the survey (203/756, 27%), of which 166 (22%) were included in the analysis. The majority of respondents were male (80%), consultant intensivists (80%), and from tertiary centres (59%). Seventeen per cent worked concurrently in ICU and anaesthesia, and 52% had not completed formal airway training within the previous 3 years. Propofol was the preferred induction agent (67%) and rocuronium was the preferred neuromuscular blocking agent (58%). Videolaryngoscopy was immediately available in 97% of the ICUs and used first-line by 43% of respondents. Sixty-one per cent of respondents were in favour of the development of Australian and New Zealand ICU airway management guidelines, and 80% agreed that airway management training should be mandatory for CICM Fellows.

**Conclusion:** Variation of practices in intubation was noted in the participants. Approximately 61% of respondents supported the development of Australian and New Zealand ICU airway management guidelines, and 80% supported mandatory airway management training.

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many procedures aimed at reducing airway complications were not commonly used in Australian and New Zealand ICUs.<sup>9</sup> Although the Australian and New Zealand College of Anaesthetists (ANZCA) has published multiple guidelines on airway management, none have focused specifically on the critically ill population in ICUs.<sup>10,11</sup> Moreover, differences in intensivists' training and staffing in the Australian and New Zealand ICU setting may warrant the development of specific local ICU airway management guidelines.

The aim of this study was to characterise intubation practices in Australian and New Zealand ICUs, and to investigate clinicians' support for the establishment of airway management guidelines in Australian and New Zealand ICUs and for the introduction of mandatory airway management continuing professional development for intensivists.

## **Methods**

### **Study design**

A prospective web-based practice survey of airway management in Australian and New Zealand ICUs was conducted in June 2018.

### **Survey instrument**

The survey was piloted by senior consultant staff in the Departments of Anaesthesia and Intensive Care at Peninsula Health. The survey questions (Table 1) were then entered into SurveyMonkey (SurveyMonkey, San Mateo, CA, USA). A detailed description of the survey can be found in the online Appendix (available at [cicm.org.au/Resources/Publications/Journal](http://cicm.org.au/Resources/Publications/Journal)).

### **Participant population**

The survey was sent via email to all members of the Australian and New Zealand Intensive Care Society (ANZICS). At the time of the survey, the mailing list included 756 medical members. The survey remained open throughout June 2018 and a reminder email was sent out 2 weeks after the initial invitation.

### **Ethical considerations**

Ethics approval was obtained from the Human Research and Ethics Committee of Peninsula Health (LNR/18/PH/18). Participation in the survey was strictly voluntary and all responses were anonymous.

### **Statistical analysis**

Survey responses were exported from the online survey platform and analysed using SPSS Statistics 20 (IBM). The data analysis was primarily descriptive and is reported as mean and standard deviation (SD) or median and interquartile range (IQR), as appropriate. Categorical data are reported as percentages of valid responses.

## **Results**

Over one-quarter of ANZICS medical members completed the survey (203/756, 27%). Participants who indicated that they worked primarily in paediatric ICUs were excluded, as were participants who only completed the demographic section of questions. One-hundred and sixty-six responses (22%) were included in the analysis (Figure 1).

### **Demographics**

Characteristics of respondents are summarised in Table 2. Seventeen per cent of respondents worked concurrently in ICU and anaesthesia, and 24% were Fellows of ANZCA. The median number of intubations performed annually by the respondents was 10 (IQR, 5–15), and the median number of supervised intubations annually was 20 (IQR, 10–25).

Most respondents (94/161, 58%) indicated that their ICU had the ability to summon assistance from a consultant anaesthetist in the event of a failed or difficult intubation, and a further 39% (62/161) responded that they were able to access such assistance only at certain times (eg, during the day).

### **Airway practices**

Propofol was the preferred induction agent (110/165, 67%), followed by ketamine (26/165, 16%) and midazolam (21/165, 13%). The preferred opioid to co-administer with an induction agent was fentanyl (150/164, 92%). Rocuronium (96/165, 58%) was the preferred agent for neuromuscular blockade, followed by suxamethonium (61/165, 37%).

The frequency with which respondents reported using different techniques or interventions for intubations performed in the ICU is shown in Figure 2. The availability of devices designed to assist with intubation in the ICU is provided in Table 3. C-Mac (KARL STORZ) was the most commonly available videolaryngoscope (68%), followed by GlideScope (Verathon) (25%) and McGrath (Medtronic) (18%). Videolaryngoscopy was used for all first attempts at intubation in 43% of respondents' ICUs (69/161).

Surgical technique was the preferred method of cricothyroidotomy (91/161, 57%) compared with needle technique (46/161, 29%), while 15% of respondents had no preference (24/161).

Most respondents (97/161, 60%) stated that their ICU did not routinely audit or collect data on intubations.

### **Airway training and guidelines**

Over half of respondents (86/165, 52%) had not completed formal airway training within the previous 3 years. Of the respondents who had completed formal airway management training in the past 3 years, 66% (56/85) had attended a course or workshop, 8% (7/85) had taught a course or workshop, 11% (9/85) had completed

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**Table 1. Summary of survey questions**

Questions	
Demographics	<ul style="list-style-type: none"> <li>▪ Age</li> <li>▪ Gender</li> <li>▪ Level of ICU</li> <li>▪ Location of the ICU</li> <li>▪ Position held in the ICU</li> <li>▪ Years of experience in this position</li> <li>▪ Whether the respondent works primarily in an adult or paediatric ICU</li> <li>▪ Whether the respondent works in both the ICU and anaesthetics</li> <li>▪ Fellowship of any Colleges</li> </ul>
Training	<ul style="list-style-type: none"> <li>▪ Familiarity with any guidelines for the intubation of critically ill patients</li> <li>▪ Participation in formal airway management/difficult intubation training in the previous 3 years</li> <li>▪ Whether they believe that having airway management guidelines for critically ill patients in Australia and New Zealand would improve the safety and quality of intubations performed in the ICU</li> <li>▪ Whether they believe that airway skills training should be included as a CPD requirement for CICM Fellows</li> <li>▪ How frequently airway skills training should be required for CICM Fellows</li> </ul>
Airway practices	<ul style="list-style-type: none"> <li>▪ Number of intubations performed per year in the ICU</li> <li>▪ Number of intubations supervised per year in the ICU</li> <li>▪ Most commonly used induction agent in the ICU</li> <li>▪ Opioid most commonly co-administered with induction agent</li> <li>▪ Most commonly used neuromuscular blocking agent in the ICU</li> <li>▪ Use of videolaryngoscopy for all first-attempt intubations</li> <li>▪ Preferred cricothyroidotomy technique</li> <li>▪ How commonly the following are used for intubations in the ICU:               <ul style="list-style-type: none"> <li>▶ intubation checklists</li> <li>▶ pre-oxygenation with non-invasive ventilation</li> <li>▶ pre-oxygenation with high-flow oxygen</li> <li>▶ apnoeic oxygenation</li> <li>▶ rapid sequence intubation</li> <li>▶ facemask ventilation with CPAP</li> <li>▶ cricoid pressure</li> <li>▶ continuous waveform capnography</li> <li>▶ intubating stylet, bougie</li> <li>▶ intubating pillows or ramps</li> <li>▶ fibre-optic intubation</li> <li>▶ delayed sequence intubation</li> </ul> </li> </ul>
Equipment availability/use	<ul style="list-style-type: none"> <li>▪ Model of videolaryngoscopy used in the ICU</li> <li>▪ Availability of videolaryngoscope</li> <li>▪ Hyperangulated laryngoscope blade</li> <li>▪ Intubating stylet</li> <li>▪ Intubating pillows or ramps</li> <li>▪ Bougie</li> </ul>

*(Continues)*

Table 1. Continued

	Questions
	<ul style="list-style-type: none"> <li>▪ Needle cricothyroidotomy kit</li> <li>▪ Fibre-optic intubation endoscope</li> <li>▪ Aintree (Cook Medical) exchange catheter</li> <li>▪ Second-generation laryngeal mask airway</li> <li>▪ Scalpel–bougie–tube cricothyroidotomy kit</li> </ul>
Organisational	<ul style="list-style-type: none"> <li>▪ Ability to summon assistance from an anaesthetist in the event of a failed intubation</li> <li>▪ Whether their ICU routinely audits data on intubations</li> </ul>

CPAP = continuous positive airway pressure. CICM = College of Intensive Care Medicine of Australia and New Zealand. CPD = continuing professional development. ICU = intensive care unit.

the ANZCA airway management continuing professional development requirements, and 14% (12/85) had received training during a formal rotation or secondment through anaesthesia departments.

Forty per cent (66/164) of respondents were not familiar with any guidelines for the intubation of critically ill patients. Sixty-one per cent of respondents (94/161) “agreed” or “strongly agreed” that the development of Australian and New Zealand ICU airway management guidelines would improve the safety and quality of intubations performed in the ICU, and 80% (129/161) “agreed” or “strongly agreed” that airway management training should be mandatory for Fellows of the College of Intensive Care Medicine of Australia and New Zealand (CICM). Most respondents preferred that this training be completed every 3 years (85/158, 54%).

### Discussion

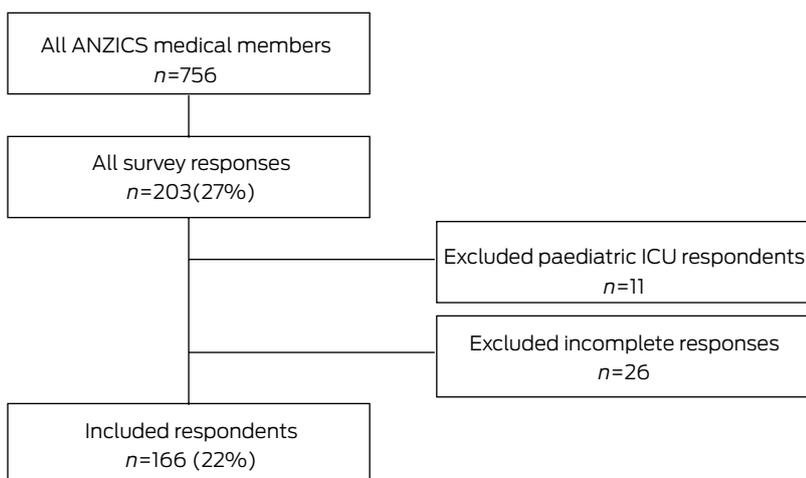
This survey showed a significant variation of ICU intubation practices among participants. To our knowledge, this is the first study to investigate whether there is support for the formation of local Australian and New Zealand ICU airway management guidelines.

The median number of intubations performed and supervised per year by respondents was 10 and 20, respectively, which is consistent with recently published data from Brewster and colleagues.<sup>12</sup> Importantly, there is no published reference recommending a certain minimum number of intubations performed or supervised to ensure that the skills required to perform intubations in intensive care are maintained. The ability to obtain assistance from anaesthetists in the event of difficult or failed intubations in the ICU appears to be widespread across the respondents’ ICUs.

Our results also demonstrated support (80%) for mandatory airway management training for Australian and New Zealand intensivists and trainees, a finding that is consistent with the results of a previous survey conducted in Australian and New Zealand ICUs.<sup>12</sup> Given this finding and the relatively large proportion of respondents who had not participated in any formal training in airway management in the previous 3 years (52%) or who were unaware of any ICU airway management guidelines (40%), it is possible that mandatory formal airway management training in Australian and New Zealand ICUs may improve the practice of airway management.

An important result from our survey was that 11% of respondents do not always use continuous waveform capnography for intubations in the ICU (Figure 2). This is despite multiple local and international

Figure 1. Recruitment diagram for the present study



ANZICS = Australian and New Zealand Intensive Care Society. ICU = intensive care unit.

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guidelines<sup>6,13</sup> and NAP4 findings,<sup>1</sup> which recommend that continuous waveform capnography should be considered a mandatory component of safe airway practice.

Recent international guidelines for intubation of critically ill patients<sup>7,13</sup> explicitly recommend that the surgical

scalpel–bougie–tube technique should be the preferred method for emergency front of neck access due to its simplicity, availability of equipment, the likely higher success rates, and the ability to provide ventilation and protection from aspiration in comparison with needle techniques.<sup>6</sup> Despite these recommendations, only 57% of survey respondents preferred the surgical technique, a finding that is consistent with those of Brewster and colleagues.<sup>12</sup> Moreover, the equipment for the scalpel–bougie–tube cricothyroidotomy technique was available in only 86% of the respondents' ICUs. Although there is no high level evidence to support one technique over the other, expert consensus and multiple guidelines<sup>6,13,14</sup> advocate the use of the surgical scalpel–bougie–tube technique and advise that all ICUs should at least have the equipment available to perform both techniques. However, the choice of preferred cricothyroidotomy technique has prompted a vigorous debate both locally and internationally,<sup>15,16</sup> and ANZCA has recommended that both the scalpel–bougie–tube technique and the cannula technique are appropriate to use first.<sup>17</sup>

Videolaryngoscopy was immediately available in 97% of respondents' ICUs but was used first-line for intubations in the ICU by only 43% of respondents (69/161). Despite high quality meta-analyses suggesting improved glottic visualisation with videolaryngoscopy and a reduction in difficult views, no studies have consistently demonstrated improved patient outcomes with the use of videolaryngoscopy and some studies have reported patient harm from its use.<sup>18–20</sup> Nevertheless, the availability of videolaryngoscopes in Australian and New Zealand ICUs in the present study is significantly higher than reported in a recent survey on videolaryngoscopy availability in British ICUs.<sup>8</sup>

The present study also revealed that checklists for ICU intubations were infrequently used by respondents, despite recommendations from the recent *Guidelines for the management of tracheal intubation in critically ill adults*.<sup>6</sup> A recent systematic review concluded that the use of checklists for ICU intubations did not provide any improvement in patient outcomes.<sup>18</sup> The inclusion of intubation checklists in future guidelines for airway management in the ICU should be reviewed in light of available evidence regarding potential benefits and risks.

Cricoid pressure has traditionally been emphasised as a precaution against pulmonary aspiration during the intubation of critically ill adults<sup>21</sup> and was explicitly recommended for this purpose in recent guidelines.<sup>6</sup> However, only 8% of survey respondents used cricoid pressure for every intubation they performed.

Suxamethonium has traditionally been considered the paralytic drug of choice for intubations in critically ill patients,<sup>21</sup> but it was preferred by only 37% of survey respondents compared with 58% of respondents who

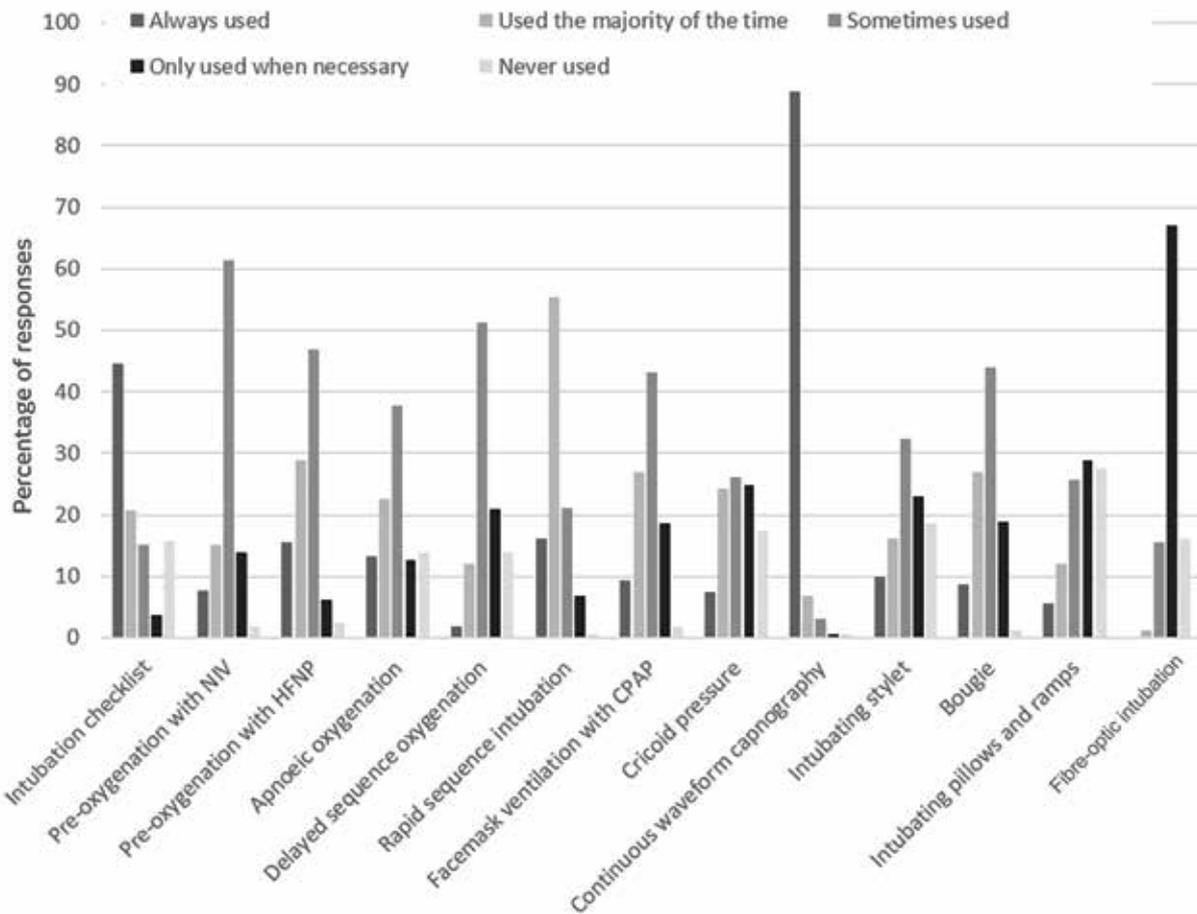
**Table 2. Characteristics of survey respondents included in the present study**

Variable	Value (%)
Total number of respondents	166
Age, years	
30–39	45 (27%)
40–49	76 (46%)
50–59	29 (18%)
≥ 60	16 (10%)
Gender	
Female	30 (18%)
Male	133 (80%)
Prefer not to say	3 (2%)
ICU category	
Tertiary	98/165 (59%)
Metropolitan	34/165 (21%)
Regional/rural	26/165 (16%)
Private	7/165 (4%)
ICU location	
New South Wales	26 (16%)
Northern Territory	3 (2%)
Queensland	32 (19%)
South Australia	5 (3%)
Tasmania	5 (3%)
Victoria	66 (40%)
Western Australia	4 (2%)
New Zealand	24 (15%)
Germany	1 (0.6%)
Position	
Consultant intensivist	133 (80%)
Career medical officer	1 (0.6%)
Trainee	32 (19%)
Years of experience in current position	
< 1	21 (13%)
1–2	12 (7%)
3–5	42 (25%)
6–10	33 (20%)
> 10	58 (35%)
Work concurrently in anaesthetics and ICU	28/164 (17%)

ICU = intensive care unit.

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Figure 2. Frequency of use of intubation techniques and supports



CPAP = continuous positive airway pressure. HFNP = high flow nasal prong. NIV = non-invasive ventilation.

preferred rocuronium. The increased respondent preference for rocuronium may be due to the ability to reverse its effects with sugammadex and the longer lasting paralysis produced by rocuronium, which likely optimises rescue techniques and the avoidance of issues with hyperkalaemia and malignant hyperthermia.<sup>22</sup>

Intubating bougies were “used always” by only 9% of survey respondents, despite it being immediately available in 99% of respondents’ ICUs. This finding is significant in light of a recent randomised controlled trial that revealed significantly higher first pass intubation success with the first-line use of bougies in patients with predicted difficult airways in emergency departments.<sup>23</sup>

Facemask ventilation with continuous positive airway pressure was explicitly recommended in the recent guidelines,<sup>6</sup> both before and between laryngoscopy attempts, as a strategy to minimise the risk of severe hypoxaemia in the peri-intubation period at the potential

cost of increasing the risk of gastric insufflation. Nevertheless, our survey revealed that this technique was used “always” by only 9% of respondents. Although there are no prospective data in critically ill patients which support this technique, it has shown increased non-hypoxic apnoea periods in non-critically ill patients and in patients with obesity.<sup>24,25</sup>

Non-invasive ventilation as a form of pre-oxygenation was used by 98% of survey respondents (155/158) during selected intubations in the ICU. Only 2% of respondents (3/158) reported that they “never used” non-invasive ventilation as a form of pre-oxygenation before intubation. Importantly, in a randomised controlled trial, this type of ventilation as a form of pre-oxygenation for ICU patients with hypoxaemia has been suggested to decrease hypoxaemia in the peri-intubation period compared with standard care with a non-rebreather bag-mask device.<sup>26</sup> Moreover, the *Guidelines for the management of tracheal*

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**Table 3. Availability of devices and interventions by type of intensive care unit (ICU)**

Available devices	All ICUs	Tertiary ICUs	Metropolitan ICUs	Regional ICUs	Rural ICUs	Private ICUs
Number of ICUs		97/162 (60%)	33/162 (20%)	21/162 (13%)	4/162 (2%)	7/162 (4%)
Videolaryngoscope	160/165 (97%)	98/98 (100%)	33/33 (100%)	19/22 (86%)	4/4 (100%)	6/7 (86%)
Hyperangulated laryngoscope blade	133/163 (82%)	82/97 (85%)	27/33 (82%)	16/22 (73%)	2/4 (50%)	6/7 (86%)
Bougie	162/163 (99%)	96/97 (99%)	33/33 (100%)	21/21 (100%)	4/4 (100%)	7/7 (100%)
Intubating stylet	154/162 (95%)	93/97 (96%)	29/31 (94%)	20/22 (91%)	4/4 (100%)	7/7 (100%)
Scalpel–bougie–tube cricothyroidotomy kit	139/161 (86%)	90/95 (95%)	25/32 (78%)	15/22 (68%)	4/4 (100%)	5/7 (71%)
Needle cricothyroidotomy kit	140/163 (86%)	82/96 (85%)	28/33 (85%)	18/22 (82%)	4/4 (100%)	7/7 (100%)
Fibre-optic intubation endoscope	140/165 (85%)	86/98 (88%)	27/33 (82%)	19/22 (86%)	3/4 (75%)	5/7 (71%)
Aintree (Cook Medical) exchange catheter	119/158 (75%)	71/93 (76%)	24/32 (75%)	15/21 (71%)	3/4 (75%)	5/7 (71%)
Second-generation laryngeal mask airway	141/165 (85%)	84/98 (86%)	27/33 (82%)	20/22 (91%)	3/4 (75%)	7/7 (100%)
Intubating pillows or ramps	58/161 (36%)	35/95 (37%)	16/33 (48%)	3/21 (14%)	1/4 (25%)	3/7 (43%)

*intubation in critically ill adults*<sup>6</sup> suggest that this technique may be beneficial in patients with hypoxaemia. Our survey results demonstrate a high utilisation of this technique.

Apnoeic oxygenation has been the focus of a growing body of literature in ICU airway management over recent years.<sup>27</sup> Despite being explicitly recommended for all intubations in critically ill patients,<sup>6</sup> apnoeic oxygenation was “used always” by only 13% of respondents in the present study. Recent results from the anaesthesia literature have demonstrated the effectiveness of apnoeic oxygenation with high flow cannula,<sup>28</sup> and a recent meta-analysis in critically ill patients demonstrated reduced levels of critical hypoxaemia and higher minimum recorded oxygen saturations.<sup>29</sup>

### Strengths, limitations and potential biases

Our study also had a number of limitations that must be acknowledged. The response rate of over one-quarter (27%) does limit the generalisability of our results to the wider Australian and New Zealand ICU community. However, our survey response rate is similar to other recently published local critical care surveys.<sup>30,31</sup> There is also likely to be a bias among the sample of respondents given that the majority worked in tertiary ICUs and almost 20% practised concurrently in anaesthesia. It may also be the case that our respondent sample consists of those with a special interest in airway management, which would represent further bias in our sample. Nevertheless, the present survey improved on previous studies by providing an opportunity for all

ANZICS members to participate in this survey regardless of location, unit size, experience or background. Our survey was also unique in that it was open to both consultant and non-consultant staff, the latter of which had not previously been included in such practice surveys despite being involved in airway management in Australian and New Zealand ICUs.<sup>12</sup> It is also worth noting that our response rate is a conservative estimate as our overall sample of ANZICS medical members included paediatric intensivists, who were not eligible to participate. It is unfortunate that ANZICS was unable to quantify how many members of this mailing list worked primarily in paediatric ICUs as they do not collect this information. Other potential biases that may have affected our study include the reliance on participant self-reporting and recall bias.

### Further directions

Given the limited sample size and response rate of our study, as well as the biases inherent in the self-report methodology, the creation of a prospective registry of Australian and New Zealand ICU airway practices may provide further valuable insight into airway management in Australian and New Zealand ICUs. The formation of a CICM or ANZICS Airway Management Special Interest Group may be a useful next step in exploring the possibility of developing local Australian and New Zealand ICU airway management guidelines and exploring potential requirements for ongoing airway management training for trainees and intensivists.

## Conclusion

This survey offers an important insight into airway management practices in Australian and New Zealand ICUs. There was significant variation in airway practices between respondents to the survey. Propofol and rocuronium were the preferred induction and neuromuscular blocking agents, respectively, and videolaryngoscopy and continuous waveform capnography were widely available but variably used. The results of this survey indicated that 61% of respondents supported the formation of local Australian and New Zealand ICU airway management guidelines, and 80% supported mandatory ongoing airway management training for intensivists.

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## Competing interests

None declared.

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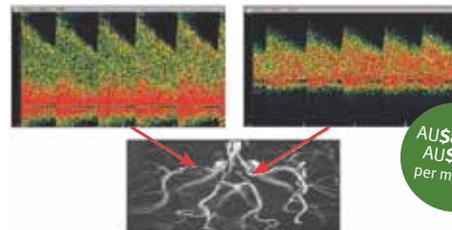
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