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Emergency airway management in a Singapore centre: A registry study

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ABSTRACT

Introduction: Intubations in the emergency department (ED) are often performed immediately without the benefit of pre-selection or the ability to defer. Multicentre observational data provide a framework for understanding emergency airway management but regional practice variation may exist. We aim to describe the intubation indications, prevalence of difficult airway features, peri-intubation adverse events and intubator characteristics in the ED of the National University Hospital, Singapore.

Methods: We conducted a prospective observational study over a period of 31 months from 1 March 2016 to 28 September 2018. Information regarding each intubation attempt, such as indications for intubation, airway assessment, intubation techniques used, peri-intubation adverse events, and clinical outcomes, was collected and described.

Results: There were 669 patients, with male predominance (67.3%, 450/669) and mean age of 60.9 years (standard deviation [SD] 18.1). Of these, 25.6% were obese or grossly obese and majority were intubated due to medical indications (84.8%, 567/669). Emergency physicians' initial impression of difficult airway correlated with a higher grade of glottis view on laryngoscopy. First-pass intubation success rate was 86.5%, with hypoxia (11.2%, 75/669) and hypotension (3.7%, 25/669) reported as the two most common adverse events. Majority was rapid sequence intubation (67.3%, 450/669) and the device used was most frequently a video laryngoscope (75.6%, 506/669). More than half of the intubations were performed by postgraduate clinicians in year 5 and above, clinical fellows or attending physicians.

Conclusion: In our centre, the majority of emergency intubations were performed for medical indications by senior doctors utilising rapid sequence intubation and video laryngoscopy with good ffirst-attempt success.

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Keywords: Difficult airway, emergency services, intubation, peri-intubation adverse events, rapid sequence induction

INTRODUCTION

Emergency airways often present with little warning, and the need for airway management is necessary for a successful resuscitation. This is in contrast to most intubations performed in the operating room (OR). Additionally, difficult airways are more prevalent in emergency department (ED) populations due to acute conditions such as blunt and penetrating trauma, burns, decompensated physiology and various pathological causes of airway obstruction.[1,2] The emergency physician needs to understand the current practice, expectations and anticipated outcomes for emergency department intubations.

Complications faced during ED intubations are numerous;[3-5] the correlation between repeated intubation attempts and the increased frequency of complications have been previously reported.[6-8] As such, minimising the number of repeated intubation attempts may help reduce

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the number of adverse events. Understanding the epidemiology of ED patients who require intubation, techniques used and success rates could allow emergency physicians to better equip themselves in airway management.

This study aims to describe the indications, methods, devices used, intubator characteristics, prevalence of difficult airway features, peri-intubation adverse events and outcomes for ED intubations at the National University Hospital (NUH), Singapore.

METHODS

Study design

This was a prospective observational study conducted at the ED of NUH over a period of 31 months from 1 March 2016 to 28 September 2018. Ethics approval was obtained for waiver of consent from the National Healthcare Group, Domain Specific Review Board (DSRB reference number: 2019/01154). The study was part of the National Emergency Airway Registry (NEAR).[3,9-11]

Study setting and eligibility criteria

The study is based in NUH, a tertiary academic hospital with over 120,000 ED visits yearly, of which about 47% of the cases require urgent (42.5%) or immediate (4.5%) care. Adult patients aged 21 years and above requiring intubation were eligible for inclusion. Patients who were under 21 years old were excluded from this study.

Variables collected

The variables collected include patient demographics, indications for intubation, pre-intubation haemodynamic status, airway assessment, preoxygenation methods, number of intubation attempts, equipment and medications used for each attempt, vital signs, confirmation of tube placement, level of intubator training, pre-intubation adverse events, and patient disposition. Body habitus was estimated visually by attending clinicians' gestalt and classified as very thin, thin, normal, obese and grossly obese. Data were collected using a standardised data collection form which was completed by the intubating physician following each intubation. Where possible, research assistants approached attending physicians for missing data to complete the forms. The data were then entered into StudyTRAX (ScienceTRAX, Macon, US), an online data entry portal with site-specific login credentials. At least 90% reporting compliance was required to maintain active data in the registry.

Statistical analysis

Results were analysed using Stata version 14 (StataCorp LP, College Station, US). Descriptive data were described in proportions. Categorical data were analysed using chi-square test or Fisher's exact test, where appropriate. Odds ratios (OR) for correlation of glottic grade with physicians' impression of difficult airway were calculated using multiple logistic regression with 95% confidence intervals (CIs) and P values reported. A P value < 0.05 was considered statistically significant.

RESULTS

Over the 31-month period, a total of 669 patients were included, with male predominance (67.3%, 450/669) and mean age of 60.9 years (standard deviation [SD] 18.1) (Table 1). Of these patients, 25.6% were obese or grossly obese, and majority were intubated due to medical indications (84.8%, 567/669). Overall, the 2 most frequent indications for intubations were cardiac arrest (31.1%, 208/669) and non-traumatic intracranial haemorrhage (13.6%, 91/669); other indications are illustrated in Table 1.

There were 38.6% (258/669) of patients with an initial impression of airway difficulty; 22.3% (149/669) had neck immobility, 6% (40/669) had facial trauma and 26.3% (176/669) had blood in airway. Of those assessed, 42.1% (90/214) of patients had Mallampati Class 3 or 4, 39.5% (156/395) had reduced mouth opening and 46.7% (189/405) had decreased thyromental distance (1 or 2 fingers). The airway features of obese and grossly obese patients are illustrated in Table 2. There were 62.7% (96/153) of obese and 94.4% (17/18) of grossly obese patients with an initial impression of airway difficulty. Among those who were examined for external airway features, 56.6% of obese and 87.5% of grossly obese had Mallampati classification of 3 and above; 45.5% of obese and 90.9% of grossly obese had reduced mouth opening.

For patients who were intubated with a video laryngoscope, all clinical predictors of an anatomically difficult airway (i.e. Mallampati, presence of reduced mouth opening, etc.) apart from facial trauma showed good correlation with glottic exposure (Table 3). Emergency physicians' initial impression of difficult airway also correlated with a worse Cormack and Lehane (CL) grade view after adjusting for type of laryngoscope used (direct versus video laryngoscope) (Table 4).

Majority of the patients in our ED underwent rapid sequence intubation (RSI) with induction and paralysis, most commonly with etomidate and succinylcholine

Table 1. Demographics (N=669)

Variables	n (%)
Male gender	450 (67.3)
Age in years, mean (SD)	60.9 (18.1)
Habitus, by visual estimation	
Very thin	28 (4.2)
Thin	142 (21.2)
Normal	328 (49.0)
Obese	153 (22.9)
Grossly obese	18 (2.7)
Indication for intubation	
Medical	567 (84.8)
Trauma	102 (15.2)
Top 10 trauma indications	**n=102**
Head injury with haemorrhage	30 (29.4)
Polytrauma	23 (22.5)
Facial trauma	16 (15.7)
Traumatic arrest	12 (11.8)
Head injury without haemorrhage	9 (8.8)
Chest trauma	4 (3.9)
Abdominal trauma	3 (2.9)
Combative/agitated	2 (2.0)
Haemorrhagic shock	2 (2.0)
Neck trauma	1 (1.0)
Top 10 medical indications	**n=567**[a]
Cardiac arrest	208 (36.7)
Intracranial haemorrhage (non-traumatic)	91 (16.1)
Pneumonia	57 (10.1)
Septic shock	44 (7.8)
Congestive cardiac failure	35 (6.2)
Cerebrovascular accident	22 (3.9)
Gastrointestinal bleed	17 (3.0)
Seizures	17 (3.0)
Acute myocardial infarction	16 (2.8)
Non-overdose altered mental state	16 (2.8)
Patient coding	
No	446 (66.7)
Yes	223 (33.3)
Sepsis suspected	119 (17.8)
Elevated ICP suspected	172 (25.7)

ICP: intracranial pressure; SD: standard deviation
[a] Total number of patients who were intubated based on medical indications.

(Table 5). The most common device used was a C-MAC video laryngoscope (72.6%, 486/669) (Table 5). For patients who were still breathing spontaneously and where the need for intubation was not immediate, 96.1% (347/361) achieved a pre-oxygenation time of more than 3 minutes. Among these patients, 83.9% (303/361) had nasal cannulae in place during the apnoeic phase. Overall, first-pass success rate at intubation was 86.5%, and was not significantly different between video and direct laryngoscopy. Postgraduate year 5 trainees, fellows and attending physicians performed more than half of the intubations. Among obese and grossly obese patients, first-pass success was 83.7% (128/153) and 66.7% (12/18), respectively and more than 60% of the first attempts were performed by postgraduate year 5 and above (Table 2). Majority of obese patients (58.2%, 89/152) had CL grade 1 glottic view while most of the grossly obese only had a grade 2 view (44.4%, 8/18) (Table 2). The most commonly encountered adverse events during intubation were hypoxia and hypotension.

Post-intubation, the most frequently used sedation and analgesic medications were propofol and fentanyl (Table 6). The median lowest SpO_2 achieved for patients with desaturation was 79% (IQR 70–85). Disposition outcomes after intubation are detailed in Table 6.

DISCUSSION

Airway management is an essential skill for emergency physicians. Difficult airway management is a norm rather than an exception due to widespread obesity and acquired difficult airway characteristics that come with an ageing patient population. There is a great prevalence of obesity worldwide,[12] with estimates that at least a third of all adults are either overweight or obese.[13] In comparison with other studies, our study cohort had a higher proportion of obese patients (25.6%).[14] Obesity has been linked with lower success rates on first intubation attempt, as well as higher risks of adverse events.[15] Difficult airways are more common in obese patients because of soft tissue causing airway obstruction, leading to difficulty with bag-valve mask ventilation, distortion of anatomy, and difficulty aligning the axis due to back adiposity. It is also associated with reduced cardiovascular reserves, respiratory reserves, and thus increases the risk of adverse outcomes such as rapid oxygen desaturation.[16] It is reassuring that first-pass success rate is high in our obese and grossly obese patients. The exact reason for good success rates is hard to determine from our observational data but is likely a result of good preparation, positioning (such as with troop pillow), high usage of video laryngoscope and operator experience. With these measures, we were

Table 2. Airway features and first-pass success rates of obese and grossly obese patients

Variables	Habitus[a]	
	Obese (n=153)	**Grossly obese (n=18)**
Initial impression of airway difficulty	96 (62.8)	17 (94.4)
Presence of neck immobility	26 (16.7)	7 (38.9)
Mallampati (n=61)[b]	**n=53**	**n=8**
Class 1	9 (17.0)	0
Class 2	14 (26.4)	1 (12.5)
Class 3	25 (47.2)	3 (37.5)
Class 4	5 (9.4)	4 (50.0)
Mouth opening (n=108)[b]	**n=97**	**n=11**
Normal	53 (54.6)	1 (9.1)
Reduced (1 to 2 FBs)	44 (45.4)	10 (90.9)
Thyromental distance (n=120)[b]	**n=109**	**n=11**
1 finger	5 (4.6)	2 (18.2)
2 fingers	58 (53.2)	5 (45.5)
3 fingers	46 (42.2)	4 (36.4)
4+ fingers	0	0
Obstruction present	8 (5.2)	3 (16.7)
Facial trauma	5 (3.3)	1 (5.6)
Blood in airway	33 (21.6)	7 (38.9)
Glottic view		
Grade 1 (full view)	89 (58.2)	4 (22.2)
Grade 2 (partial view)	46 (30.1)	8 (44.4)
Grade 3 (epiglottis only)	12 (7.8)	5 (27.8)
Grade 4 (no view)	6 (3.9)	1 (5.6)
First-pass success	128 (83.7)	12 (66.7)
Intubator level		
PGY 1	5 (3.3)	0
PGY 2	25 (16.3)	2 (11.1)
PGY 3	8 (5.2)	1 (5.6)
PGY 4	23 (15.0)	1 (5.6)
PGY ≥5 or fellow	67 (43.8)	6 (33.3)
Attending	25 (16.3)	8 (44.4)

FB: fingerbreadth; PGY: postgraduate year
[a] Habitus estimated visually by attending clinicians.
[b] Not assessed in the rest of the patients.

able to achieve a grade 1 or 2 glottic view in majority of these patients. Hence, although the increased prevalence of obesity with its associated risks and complications may pose challenges in airway management for emergency physicians,[15,17] appropriate steps taken can still allow an adequate first-pass success rate.

Another cause for concern in airway management is the increasing number of geriatric patients seen in the ED. Our study cohort had a median age of 60.9 years, which is higher than that of other studies.[18] This is congruent with the increasing ageing population seen in Singapore's healthcare system.[19] Ageing is associated with changes in the airway manifested through edentulous mouth, glottic muscle atrophy and reduced neck mobility, which increases the difficulty of ventilation and intubation.[20] The higher prevalence of comorbidities like chronic obstructive pulmonary disease and gastroesophageal reflux disease increases the risk of aspiration pneumonia.[20] In addition, the elderly are more prone to adverse events such as myocardial ischaemia and hypotension due to labile blood pressure responses during induction,[20] and varying types and dosages of induction

Table 3. Difficult airway characteristics (N=669)

Airway features	Direct laryngoscope					Video laryngoscope				
	Glottis grading n (%)				*P* value	Glottis grading n (%)				*P* value
	Grade 1 **(n=78)**	Grade 2 **(n=61)**	Grade 3 **(n=21)**	Grade 4 **(n=3)**		Grade 1 **(n=332)**	Grade 2 **(n=133)**	Grade 3 **(n=24)**	Grade 4 **(n=17)**	
Initial impression of airway difficulty	17 (21.8)	20 (32.8)	12 (57.1)	2 (66.7)	0.007[a]	117 (35.2)	62 (46.6)	17 (70.8)	11 (64.7)	<0.001
Habitus, by visual estimation					0.070[a]					0.048
Very thin	5 (6.4)	3 (4.9)	1 (4.8)	0		13 (3.9)	5 (3.8)	0	1 (5.9)	
Thin	23 (29.5)	11 (18.0)	3 (14.3)	0		72 (21.7)	31 (23.3)	0	2 (11.8)	
Normal	34 (43.6)	33 (54.1)	10 (47.6)	2 (66.7)		170 (51.2)	57 (42.9)	14 (58.3)	8 (47.1)	
Obese	16 (20.5)	13 (21.3)	4 (19.1)	0		73 (22.0)	33 (24.8)	8 (33.3)	6 (35.3)	
Grossly obese	0	1 (1.6)	3 (14.3)	1 (33.3)		4 (1.2)	7 (5.3)	2 (8.3)	0	
Presence of neck immobility	10 (12.8)	9 (14.8)	6 (28.6)	2 (66.7)	0.046[a]	73 (22.0)	28 (21.1)	13 (54.2)	8 (47.1)	<0.001
Mallampati (n=214)[b]	**n=23**	**n=16**	**n=5**	**n=1**	0.001[a]	**n=105**	**n=45**	**n=13**	**n=6**	0.006[a]
Class 1	10 (43.5)	1 (6.3)	1 (20.0)	0		29 (27.6)	6 (13.3)	0	1 (16.7)	
Class 2	10 (43.5)	9 (56.3)	0	0		40 (38.1)	13 (28.9)	3 (23.1)	1 (16.7)	
Class 3	3 (13.0)	4 (25.0)	4 (80.0)	0		32 (30.5)	21 (46.7)	8 (61.5)	2 (33.3)	
Class 4	0	2 (12.5)	0	1 (100.0)		4 (3.8)	5 (11.1)	2 (15.4)	2 (33.3)	
Mouth opening (n=395)[b]	**n=37**	**n=31**	**n=10**	**n=1**	0.106	**n=204**	**n=81**	**n=19**	**n=12**	<0.001[a]
Normal	31 (83.8)	19 (61.3)	6 (60.0)	1 (100.0)		138 (67.6)	35 (43.2)	6 (31.6)	3 (25.0)	
Reduced (1 to 2 FBs)	6 (16.2)	12 (38.7)	4 (40.0)	0		66 (32.4)	46 (56.8)	13 (68.4)	9 (75.0)	
Thyromental distance (n=405)[b]	**n=40**	**n=27**	**n=13**	**n=1**	0.016[a]	**n=211**	**n=83**	**n=19**	**n=11**	0.001[a]
1 finger	0	0	1 (7.7)	0		2 (0.9)	4 (4.8)	1 (5.3)	3 (27.3)	
2 fingers	11 (27.5)	17 (63.0)	5 (38.5)	1 (100.0)		86 (40.8)	44 (53.0)	10 (52.6)	4 (36.4)	
3 fingers	28 (70.0)	10 (37.0)	7 (53.8)	0		119 (56.4)	35 (42.2)	7 (36.8)	4 (36.4)	
4+ fingers	1 (2.5)	0	0	0		4 (1.9)	0	1 (5.3)	0	
Obstruction present	3 (3.8)	1 (1.6)	2 (9.5)	0	0.310[a]	10 (3.0)	7 (5.3)	2 (8.3)	3 (17.6)	0.024[a]
Facial trauma	2 (2.6)	2 (3.3)	1 (4.8)	0	0.846[a]	21 (6.3)	10 (7.5)	1 (4.2)	3 (17.7)	0.297[a]
Blood in airway	14 (17.9)	20 (32.8)	10 (47.6)	1 (33.3)	0.023[a]	77 (23.2)	34 (25.6)	12 (50.0)	8 (47.1)	0.006

FB: fingerbreadth; Glottis grading: based on the Cormack and Lehane (CL) classification.
[a] Fisher's exact test.
[b] Not assessed in the rest of the patients.

Table 4. Odds ratios of impression of airway difficulty with glottic grading (N=669)

Variables	Presence of airway difficulty on initial impression (OR)	95% CI	*P* value
Grade of glottic view			
Grade 1 (full view)	Reference		
Grade 2 (partial view)	1.63	1.14 to 2.34	0.007
Grade 3 (epiglottis only)	4.52	2.32 to 8.81	<0.001
Grade 4 (no view)	3.79	1.47 to 9.79	0.006
Type of device			
Direct laryngoscope	Reference		
Video laryngoscope	1.84	1.23 to 2.73	0.003

CI: confidence interval; OR: odds ratio

Table 5. Intubation attempts (N=669)

Variables	Attempt 1 (n=669)	Attempt 2 (n=90)	Attempt 3 (n=15)[a]	Attempt 4 (n=5)[b]
Success	579 (86.5)	74 (82.2)	9 (60.0)	3 (60.0)[c]
Methods of intubation				
Sedation and paralysis	450 (67.3)	2 (2.2)	2 (13.3)	0
Sedation only	2 (0.3)	0	0	0
Paralysis only	13 (1.9)	5 (5.6)	0	1 (20.0)
Topical anaesthesia	1 (0.2)	0	0	1 (20.0)
No meds	203 (30.3)	83 (92.2)	0	0
Induction agent	**n=452**	**n=2**	**n=2**	
Etomidate	319 (70.6)	1 (50)	2 (100.0)	0
Ketamine	85 (18.8)	0	0	0
Midazolam	2 (0.4)	0	0	0
Propofol	46 (10.2)	1 (50)	0	0
Paralysis agent	**n=463**	**n=7**	**n=2**	**n=1**
Rocuronium	36 (7.8)	1 (14.3)	1 (50.0)	0
Succinylcholine	427 (92.2)	6 (85.7)	1 (50.0)	1 (100.0)
Intubator specialty[d]				
Emergency medicine	475 (71.0)	86 (95.6)	12 (80.0)	2 (40.0)
Anaesthesia	0	2 (2.2)	3 (20.0)	3 (60.0)
Paediatrics	2 (0.3)	0	0	0
General surgery	17 (2.5)	1 (1.1)	0	0
Internal medicine	100 (15.0)	0	0	0
Family medicine	73 (10.9)	0	0	0
Physician assistant	1 (0.15)	0	0	0
Paediatric emergency medicine	1 (0.15)	1 (1.1)	0	0
Intubator level	**n=668**			
PGY 1	14 (2.1)	0	0	0
PGY 2	128 (19.2)	0	0	0

Table 5. Intubation attempts (N=669) (Cont'd)

Variables	Attempt 1 (n=669)	Attempt 2 (n=90)	Attempt 3 (n=15)[a]	Attempt 4 (n=5)[b]
PGY 3	62 (9.3)	0	0	0
PGY 4	95 (14.2)	6 (6.7)	0	0
PGY ≥5 or fellow	265 (39.7)	27 (30.0)	3 (20.0)	2 (40.0)
Attending	104 (15.5)	57 (63.3)	12 (80.0)	3 (60.0)
Position during intubation				
C-spine extension only	69 (10.3)	9 (10.0)	1 (6.6)	0
Full sniffing position	406 (60.7)	46 (51.1)	7 (46.7)	1 (20.0)
Neutral C-spine	190 (28.4)	34 (37.8)	7 (46.7)	4 (80.0)
Ramped position	2 (0.3)	0	0	0
Seated upright	2 (0.3)	1 (1.1)	0	0
Device used				
Clarus video system	1 (0.1)	0	0	0
C-MAC standard blade	474 (70.9)	51 (56.7)	5 (33.3)	1 (20.0)
C-MAC D blade	12 (1.8)	6 (6.7)	1 (6.7)	1 (20.0)
C-MAC straight blade	0	2 (2.2)	0	0
Direct laryngoscope (MacIntosh)	163 (24.4)	25 (27.8)	6 (40.0)	0
Fingers/digital	0	1 (1.1)	0	0
McGrath video laryngoscope	19 (2.8)	4 (4.4)	2 (13.3)	2 (40.0)
Surgical cric set	0	1 (1.1)	1 (6.7)	1 (20.0)
BURP used	295 (44.1)	53 (58.9)	11 (73.3)	4 (80.0)
Bougie used	85 (12.7)	41 (45.6)	11 (73.3)	3 (60.0)
Route				
Oral	669 (100)	88 (97.8)	14 (93.3)	5 (100.0)
Surgical	0	2 (2.2)	1 (6.7)	0
Number of patients with adverse events during intubation	92 (13.8)	9 (10.0)	2 (13.3)	2 (40.0)
Type of adverse event[e]	**n=92**	**n=9**	**n=2**	**n=2**
Hypoxia	64 (69.6)	8 (88.9)	1 (50.0)	2 (100.0)
Hypotension	21 (22.8)	2 (20.0)	1 (50.0)	0
Cardiac arrest	7 (7.6)	0	0	0
Vomiting	4 (4.3)	0	0	0
Bradycardia	2 (2.2)	0	0	0
Dental trauma	3 (3.3)	0	0	1 (50.0)
Main stem intubation	2 (2.2)	0	0	0
Tachydysrhythmia	2 (2.2)	0	0	0
Laryngospasm	1 (1.1)	0	0	0
Pneumothorax	0	1 (11.1)	0	0

BURP: backward, upward and right pressure; C-spine: cervical spine; cric: cricothyroidotomy; PGY: postgraduate year
[a] One patient died hence there was no additional attempt.
[b] One patient had extraglottic device inserted.
[c] Two patients with failed attempts; 1 had extraglottic device inserted, 1 had intubation taken over by anaesthesia team.
[d] The intubations done by intubators from paediatric emergency medicine and paediatrics were by trainees in these residency training programmes who had rotated to the adult emergency department for an elective posting.
[e] Proportions calculated using number of patients with adverse events as denominator; total percentage is more than 100% as each patient may have more than one adverse event.

Table 6. Outcomes and subsequent management (N=669)

Variables	n (%)
Confirmation of placement	
Qualitative $ETCO_2$	451 (67.4)
Quantitative $ETCO_2$	181 (27.1)
Auscultation of lungs	657 (98.2)
Condensation in tube	358 (53.5)
Bedside ultrasound	12 (1.8)
Bougie	35 (5.2)
Peri-intubation desaturation[a] (n=446)	57 (12.8)
Lowest SpO_2 during desaturation, median (IQR)	79 (70–85)
Hypotensive 15 mins after intubation[a] (n=446)	61 (13.7)
Lowest systolic blood pressure in mmHg, median (IQR)	80 (66–87)
Treatment required for hypotensive episodes (n=61)	45 (73.8)
Disposition	
ICU	375 (56.0)
Died in ED (unrelated to failed airway)	156 (23.3)
OT	94 (14.1)
Extubated in ED	3 (0.5)
Transferred	41 (6.1)
Post-intubation medications	
Propofol	355 (53.1)
Midazolam	6 (0.9)
Diazepam	2 (0.3)
Ketamine	18 (2.7)
Fentanyl	268 (40.1)
Paralytic	40 (6.0)
Pressor	58 (8.7)
Morphine	2 (0.3)
No medication	196 (29.3)

ED: emergency department; $ETCO_2$: end-tidal carbon dioxide; ICU: intensive care unit; IQR: interquartile range; OT: operating theatre; SpO_2: peripheral capillary oxygen saturation
[a] Information available in 446 patients.

agents that may be required compared to those for the younger patients. In view of such differences, management of emergency airways in the elderly population should be individualised and tailored accordingly.

Apart from obesity and ageing, other airway features such as a higher Mallampati score, presence of airway obstruction, reduced mouth opening, thyromental distance and neck mobility can also complicate airway management. In our study, these key features of initial airway assessment directly corresponded to the severity of the glottis grading in each patient. Emergency physicians' initial impression of difficult airway were also consistent with actual glottic grading. Nevertheless, the prediction of airway difficulty was not 100% accurate and emergency physicians should still be sufficiently prepared to deal with a challenging intubation. Although it is well documented that the presence of facial trauma is associated with difficult airway,[21] it is interesting to note that the patients with facial trauma in this study were not significantly associated with a higher glottic grade. Possible reasons include early anticipation of a difficult airway with adequate preparation prior to intubation, such as optimal jaw thrust with assistance, thus allowing better alignment of the airway for improved glottic view.

In our cohort, RSI was the most common method used during first intubation attempts (67.3%), similar to the reported frequencies of RSI use in the US and Canada EDs.[11] RSI is the preferred method in the ED[3-5,11,22,23] predominantly due to the patient population. ED patients are often unfasted with a higher risk of aspiration, and RSI has been associated with high intubation success rates[3,23-26] as it allows for reliable and rapid intubating conditions. In our institution, succinylcholine (92.2%) is more commonly used as a paralytic agent for RSI than rocuronium (7.8%). This is likely cultural as the use of neuromuscular blocking agents (NMBAs) in the multicentre NEAR project is roughly split evenly between rocuronium and succinylcholine. Historically, the majority of ED providers used succinylcholine as an NMBA due to its rapid onset of action, short duration of action and presence of fasciculations, allowing physicians to visually determine the onset of muscle paralysis.[27] However, in several pathological states that upregulate muscle nicotinic acetylcholine receptors—such as direct muscle trauma, physical or chemical denervation, muscle relaxants or toxins and burns—the risk of succinylcholine-induced hyperkalemia is high.[28]

Recent studies demonstrating similar success rates in first-pass intubations between rocuronium and succinylcholine may prompt more usage of rocuronium at our institution for RSI in the future since rocuronium lacks the risk of hyperkalemia.[10] Additionally, rocuronium has an excellent safety profile with the main (although rare) adverse effect, being allergy.[27] Lastly, the initial concern of rocuronium's longer duration of action has been addressed with the introduction of a specific reversal agent, sugammadex.[29] This could alleviate ED physicians' concerns of prolonged respiratory paralysis when using rocuronium, in situations where repeated intubation attempts are unsuccessful.

In addition to achieving high first-attempt intubation success rates, we were also able to attain an adverse event rate of 13.8%, which is lower than other institutions in Singapore (23.2%)[18] and comparable to the US centres (12%).[3] Increasing intubation attempts prolongs the apnoeic time, resulting in higher rates of peri-intubation complications.[7,8] This further reiterates the importance of improving first-pass success rates to limit the number of intubation attempts. In our institution, the use of the Vortex approach has also aided in limiting the number of attempts in rare occasions of intubation failures. The Vortex approach is an implementation template to guide practitioners in high-stake situations, ensuring that a maximum of 3 attempts of each technique—face mask, supraglottic airway and endotracheal intubation—is done, after which a "cannot-intubate, cannot-oxygenate" rescue technique must be initiated.[30] Inherent to our practice, appointed time-keepers help to read out aides, prompting operators when the next attempt in the Vortex approach is due. This prevents overzealous operators from persisting in intubation and prolonging hypoxia.

Of note, the majority of our patients received propofol (53.1%, 355/669) and fentanyl (40.1%, 268/669) as sedative agents post-intubation. This is similar to the entire NEAR cohort where 66% of those who received post-intubation sedation had propofol and 42.6% were given fentanyl infusion.[31] Although propofol and fentanyl may cause haemodynamic instability, in our dataset, only 9.2% and 13.4% respectively were documented to be hypotensive within 15 minutes post-intubation (information on post-intubation hypotension available in 446 patients). It is impossible to determine whether the choice of agent contributed to post-intubation hypotension or if it was due to the underlying disease pathology.

The strength of our study lies in the prospective and real-time collection of variables during the intubation attempts, such as the predictors of a difficult airway that were properly assessed before the actual intubation. This allows for a more precise comparison on the accuracy of airway prediction in this study, by minimising recall bias and information loss, to preserve data integrity.

Limitations

Our study has its limitations. Firstly, this is a single-centre study and the results may not be generalisable to other institutions or patient cohort. Second, there were some predictors of a difficult airway that were not used during patient evaluation in our study. Examples include the relationship between maxillary and mandibular incisors, the presence of a prominent "overbite", neck length, and shape of palate.[32] Hence, we were not able to describe the prevalence and predictive value of these features in our patient cohort. Third, it is not routine clinical practice to weigh the patients before emergency intubation due to imminent need to secure the airway; thus, information collected regarding patients' habitus was assessed by visual estimation and clinicians' gestalt.

Fourth, although airway features were assessed prior to intubation, not all of the data collection forms were filled before the intubation attempts. In such cases where the data forms were filled after completion of intubation, impression of airway difficulty might be influenced by the glottic view and difficulty experienced during the attempt, which might have affected how intubators recorded their "gestalt" of difficulty. However, given the time-sensitive nature of this life-saving procedure, documenting this information prior to intubation was not always possible. Fifth, our study has a smaller sample size compared to other studies conducted on intubations in the ED. Nonetheless, the study provides a representation of ED-specific information on intubation and airway management. Lastly, the incidence of adverse events was too low for any meaningful association between operator experience, or choice of induction or paralytic agent to be established.

CONCLUSION

In our single-centre cohort, the majority of intubations were performed for medical indications by senior trainees or fellows utilising RSI and video laryngoscopy with good first-attempt success.

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