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Clinical paper

Out-of-Hospital emergency airway management practices: A nationwide observational study from Aotearoa New Zealand

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Abstract

Background and Objectives: Airway management is crucial for emergency care in critically ill patients outside the hospital setting. An Airway Registry is useful in providing essential information for quality improvement purposes. Therefore, this study aimed to develop an out-of-hospital airway registry and describe airway management practices in Aotearoa New Zealand (AoNZ).

Methods: Data from the Aotearoa New Zealand Paramedic Care Collection (ANZPaCC) database were used in a retrospective cohort study covering July 2020 to June 2021. All patients receiving airway interventions were included. An airway intervention was defined as one or more of the following: non-drug assisted endotracheal intubation (NDA-ETI), drug-assisted endotracheal intubation (DA-ETI; where a combination of paralytic agent and sedative were used to aid in intubation), laryngeal mask airway (LMA), oropharyngeal airway (OPA), nasopharyngeal airway (NPA), surgical airway (cricothyroidotomy), suction, jaw thrust. Descriptive statistics were analysed using Chi-Square and logistic regression modelling investigated the relationship between advanced airway success and patient characteristics.

Results: The study included 4,529 patients who underwent 7,779 airway interventions. Basic airway interventions were used most frequently: OPA (45.1%), NPA (29.3%), LMA (28.9%), suction (19.9%) and jaw thrust (17.6%). Advanced airway interventions were used less frequently: NDA-ETI (19.8%), DA-ETI (8.7%), and surgical airways (0.2%). The success rate for ETI (including both NDA-ETI and DA-ETI) was 89.4%, with NDA-ETI success at 85.8% and DA-ETI success at 97.7%. ETI first-pass success rates were significantly lower for males (aOR 0.65, 95%CI 0.48–0.87, $p < 0.001$) and higher for non-cardiac arrest injury patients (aOR 2.94, 95%CI 1.43–6.00, $p < 0.001$). In this cohort receiving airway interventions the 1-day mortality rate was 41.1%, demonstrating that a high proportion of these patients were severely clinically compromised.

Conclusions: Out-of-hospital airway management practices and success rates in AoNZ are comparable to those elsewhere. This research has determined the variables to be used as the AoNZ Paramedic Airway Registry ongoing and has demonstrated baseline outcomes in airway management for ongoing quality improvement using this registry.

Keywords: Airway, Endotracheal Intubation, Rapid Sequence Induction, Oropharyngeal, Nasopharyngeal, Paramedic, EMS, New Zealand, Emergency

Introduction

Airway management is a cornerstone of Emergency Medical Services (EMS) training and practice across the globe. Airway interventions are typically required for seriously ill or injured patients suffering from impaired consciousness. The failure to adequately secure and protect a patient's airway can lead to hypoxic brain injury and death.

There are wide-ranging variations in the use and outcomes of airway interventions internationally. In 2021, the National Association of EMS Physicians (NAEMSP) in the United States of America released a position statement advocating for a robust and uniform quality management paradigm for prehospital systems.[1] Our study responds to that call for evidence concerning out-of-hospital airway management.

Several airway registries have been developed to characterise airway management practices and undertake quality improve-

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ment.[2–5] The largest out-of-hospital airway registry is a subset of the data collected by the National Emergency Medical Services Information System (NEMSIS) project in North America, containing over 43 million EMS records.[5,6] Similarly, Aotearoa New Zealand (AoNZ) has an EMS data repository, the *Aotearoa New Zealand Paramedic Care Collection (ANZPaCC)*, that holds routinely collected clinical data from EMS electronic patient care records. The primary aims of this study were to utilise data extracted from ANZPaCC to develop an out-of-hospital airway registry and describe the airway management practices in AoNZ. A secondary aim was to establish the success rates of EMS advanced airway interventions.

Methods

Study design

This was a retrospective cohort study describing airway management practices in AoNZ over a 12-month period from 1 July 2020 to 30 June 2021. This was a national study covering a population of 5.1 million and a land area of 264,920 square kilometres.[7,8]

AoNZ EMS system

Hato Hone St John is the largest EMS provider, servicing 90% of the AoNZ population, attending approximately 500,000 incidents annually. The Wellington Free Ambulance serves the Wellington region, approximately 10% of the NZ population. All clinical procedures that can be performed by AoNZ EMS (both, Hato Hone St John and Wellington Free Ambulance) are described in detail in the New Zealand Clinical Procedures and Guidelines, which form the standing orders that EMS practice under.[9] Details regarding the tiered response system and emergency call centre are as described elsewhere.[10]

Training of EMS personnel

There are currently five levels of EMS staff who can provide airway interventions: First Responder (FR; certificate in emergency care qualified), Emergency Medical Technician (EMT; diploma or degree qualified), Paramedic (PARA; degree qualified), Intensive Care Paramedic (ICP; postgraduate certificate qualified) and Critical Care Paramedic (CCP; postgraduate diploma qualified). FRs can use OPA and NPA devices, while EMTs and registered PARA can also use LMA. Registered ICPs can perform NDA-ETI. CCPs can perform NDA-ETI and DA-ETI as they have additional airway training as part of their postgraduate diploma qualification. Airway interventions can be performed autonomously following standing orders guidelines by all levels of EMS, without direct physician oversite. At present, there are no guidelines specific to retaining ETI competency in AoNZ. However, CCPs are operating in areas with high skill needs, optimising and maximising the practice of advanced airway skills.

Indications for performing ETI

DA-ETI is indicated for patients with a GCS of less than or equal to 10, with a clinically significant compromise of airway or ventilation. The decision to use DA-ETI is at the discretion of the attending CCP, who must take into account all of the factors contributing to the balance of risk for that patient. NDA-ETI can only occur in circumstances where the patient has a GCS of 3 and ineffective breathing.[9]

Aotearoa New Zealand, Paramedic care Collection (ANZPaCC)

All EMS in AoNZ use the same electronic patient report form (ePRF) when attending patients. ANZPaCC contains all routinely collected clinical data from the ePRF for all patients attended by road EMS (excluding air transport) in AoNZ. In addition, ANZPaCC is linked to data elements such as mortality and ethnicity from Manatū Hauora (Ministry of Health) records. The full details of data variables contained within these datasets are described in the ambulance care standard and the Manatū Hauora data dictionaries.[11,12] Access to, and use of the de-identified ANZPaCC dataset is co-governed by Wellington Free Ambulance and Hato Hone St John.

Inclusion and exclusion criteria

All patients who had airway management performed were included in the study. Airway interventions included: non-drug assisted endotracheal intubation (NDA-ETI), drug-assisted endotracheal intubation (DA-ETI*;* where a combination of paralytic agent and sedative were used to aid in intubation, a.k.a. Rapid Sequence Intubation/RSI), laryngeal mask airway (LMA), oropharyngeal airway (OPA), nasopharyngeal airway (NPA), surgical airway (cricothyroidotomy), suction, and jaw thrust (head tilt/chin lift are included as a jaw thrust).

Geographic areas

A meshblock is the smallest population unit for which statistical data is collected and processed by Statistics NZ.[13] A meshblock is defined by a discrete number of people living within a cohesive geographic area; the area can vary in size from part of a city block to a large area of rural land. The 2018 meshblock of the incident location was used to determine rurality, defined as: ‘urban’ (includes major, large, medium and small urban areas) and ‘rural’ (includes rural settlement, rural other).[14]

Demographic and clinical variables

Demographic and clinical variables include age, sex, ethnicity, clinical aetiology (cardiac arrest, non-cardiac arrest medical, non-cardiac arrest injury) and deprivation index.

This study allocated a single ethnicity per individual based on a prioritisation hierarchy according to Manatū Hauora as described in the HISO 10001:2017 Ethnicity Data Protocols HISO.[15] Ethnicities analysed were: European (including New Zealand European), Māori (the indigenous population of New Zealand), Pacific Peoples (people predominantly from South Pacific Islands including Samoa, Cook Islands, Tonga and Niue), and Asian/Middle Eastern/Latin American/African (Asian & MELAA). Residual categories were categorized as missing data and included ‘don’t know’, ‘refused to answer’, ‘response unidentifiable’, ‘not stated’, and ‘other’.

The deprivation index is a socioeconomic measure scoring from 1 to 10, with decile 10 areas being the 10% most deprived.[16] The deprivation index takes several factors into account, including income, employment, overcrowding, and education. Deprivation was determined from the 2018 meshblock of the patient’s residential address. Scores were up-grouped into quintiles.

Prevalence of airway type used

For the purposes of the total number of different airway interventions, if a specific airway intervention was performed more than once on a single patient it was only recorded once. For example, if a patient received three attempts at ETI, a single case was recorded in the total number of endotracheal intubations.

However, if a patient had more than one different airway type applied, these were counted separately. For example, if a patient received an OPA, which was replaced by an LMA, and then a subsequent ETI, the patient was classified as having three separate airway interventions.

The ETI group (NDA-ETI and DA-ETI combined)

Any patient who received a NDA-ETI or a DA-ETI attempt (either successful or unsuccessful) was categorised to the ETI group, regardless of whether they received any other airway intervention.

Characteristics of patients receiving ETI compared to all other airway interventions

Binary grouping was used: either ETI or Other. The Other group were patients who received no ETI attempt.

Overall success for the ETI group

Within the clinical record there is an option allowing for the selection of 'successful' or 'unsuccessful' whenever an ETI airway intervention is attempted, regardless of how many attempts were performed. This successful/unsuccessful checkbox was used as the data record for successful ETI placement.

First-pass success for the ETI group

First-pass success is successful intubation with a single attempt. An attempt was defined as the insertion of a laryngoscope into the mouth with the intent of passing an ETT into the trachea.

Incidence of clinically significant physiological changes and 1-day mortality

Clinically significant physiological changes were defined as any of the following occurring after the airway intervention had been administered whilst in EMS care and prior to arrival at a medical facility: low mean arterial pressure (L-MAP,<65 mmHg), low systolic blood pressure (LSBP, Systolic BP < 90), bradycardia (HR = 1 to 50/min), hypoxia (SpO_2 < 90%) mmHg). Mortality was calculated as death occurring within 1-day of the phone call to EMS.

Statistical analysis

Variables were described as totals and percentages of total numbers. A Pearson Chi-Squared test and the z-test for column proportions was used to compare nominal values. Univariable and multivariable logistic regression was used to investigate differences in ETI success rates according to clinical and demographic variables. For multivariable regression, the variables ETI type, age, sex, ethnicity, aetiology, population setting, and socioeconomic deprivation were included by forced entry in a forward conditional model. Data are presented as unadjusted and adjusted odds ratios (OR) with 95% confidence intervals (CI). Data analysis was performed using IBM SPSS (V.28.0). A P-value < 0.05 was considered statistically significant.

Results

Between 1 July 2020 and 30 June 2021, EMS in AoNZ received 582,200 emergency calls of which 435,300 (74.8%) resulted in EMS attendance. Of the attended patients, 1.1% (4,592 patients) received one or more airway interventions (Fig. 1). Basic airway interventions were used most frequently: OPA (45.1%, n = 2,072), NPA (29.3%, n = 1,344), LMA (28.9%, n = 1,328), suction (19.9%, n = 912) and jaw thrust (17.6%, n = 807). Advanced airway interventions were used less frequently: NDA-ETI (19.8%, n = 907), DA-ETI (8.7%, n = 399) and surgical airways (0.2%, n = 10) (Table 1). Of the patients receiving airway interventions, 43.5% (n = 2,153) patients had more than one airway intervention.

Higher proportions of patients receiving airway interventions were aged >19 years (92.1%), male (60.7%), European (55.9%), in cardiac arrest (46.0%), in urban locations (75.8%), and from the highest level of socioeconomic deprivation (31.3%) (Table 2). Compared to basic airways, ETI interventions were administered at proportionately higher rates in patients 19–84 years old, males, Pacific Peoples, cardiac arrest cases, urban locations, and our least socioeconomically deprived communities (Table 2).

Overall success rates

ETI was performed in a total of 1,306 patients (Table 3). Overall success rates were 89.4%, with DA-ETI (97.7%) having a higher success rate compared to NDA-ETI (85.8%). The odds of success in DA-ETI were three times higher than the odds of success in NDA-ETI (aOR 3.31, 95%CI 1.35–8.09, p < 0.05) (Table 3).

ETI overall success rates were similar across all ages and deprivation quintiles (Table 3). However, overall success rates for ETI were lower for males (88.1%) than females (92.3%). Following adjustment for confounding the odds of success in males was similar to females (aOR 0.67, 95%CI 0.43–1.04, p = 0.07) (Table 3).

ETI success rates were also lower for patients presenting with cardiac arrest (86.3%) compared to non-arrest medical (98.1%) and non-arrest injury (98.9%) cases. The odds of success in injury events were eleven-times higher than in cardiac arrest events (aOR 11.78, 95%CI 1.48–93.94, p < 0.05), but were not significantly higher for medical events (aOR 2.95, 95%CI 0.75–11.62, p = 0.12) (Table 3).

First-pass success

Overall, the first-pass success rate for ETI was 71.3% (Table 4). First-pass success rates did not differ significantly according to age, socioeconomic deprivation, or ethnicity (Table 4).

First-pass success rates were lower for NDA-ETI (64.1%) compared to DA-ETI (87.9%). The odds of first-pass success in DA-ETI were two-times greater than in NDA-ETI (aOR 2.64, 95%CI 1.6–4.36, p < 0.001) (Table 4).

First-pass success rates were lower in males (68.3%), with significantly reduced odds of first-pass success in males than females (aOR 0.65, 95%CI 0.48–0.87, p < 0.001) (Table 4).

There was lower first-pass success in patients presenting with cardiac arrest (65.2%). The odds of first-pass success in non-arrest injury patients were two-times greater than in cardiac arrest patients (aOR 2.94, 95%CI 1.43–6.07, p < 0.001) (Table 4).

There were also differences in rurality, with higher first-pass success in rural locations (78.3%) compared to urban locations (69.4%). The odds of first-pass success in the rural setting were 1.5-times higher than in the urban environment (aOR 1.46, 95%CI 1.01–2.1, p < 0.05) (Table 4).

Clinically significant physiological changes and 1-day mortality

Incidence of clinically significant physiological changes and 1-day mortality were variable depending on airway type and aetiology

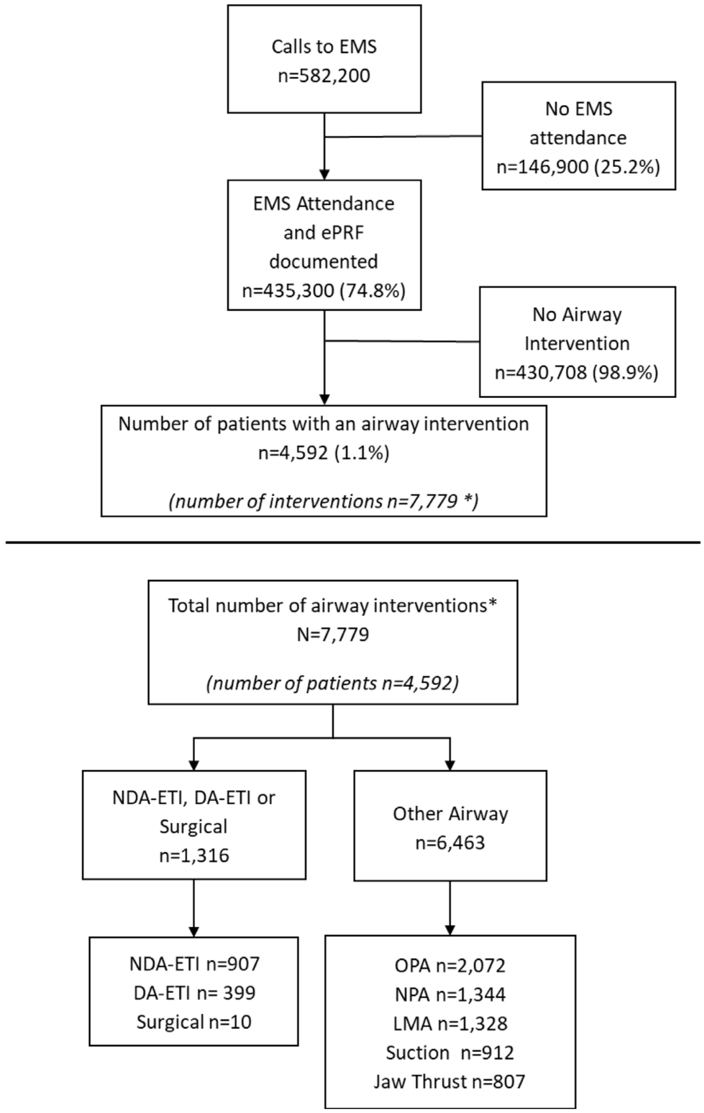

Fig. 1 – Airway management events within the dataset. * If a patient had more than one different airway intervention attempted these would be counted as separate events therefore the number of airways documented is greater than the number of patients.

Table 1 – Prevalence of airway management interventions.

Airway Interventions	Number of airway interventions (n = 7,779)	The proportion of patients receiving intervention (n = 4,592) (%)
OPA	2072	45.1%
NPA	1344	29.3%
LMA	1328	28.9%
Suction	912	19.9%
NDA-ETI	907	19.8%
Jaw Thrust*	807	17.6%
DA-ETI	399	8.7%
Surgical	10	0.2%

* Head tilt chin lift included as a jaw thrust.

(Table 5). Across the total airway management cohort, the most prevalent physiological change was bradycardia (35.8%), followed by hypoxia (15.3%), low mean arterial blood pressure (12.2%), and low systolic blood pressure (11.4%). The overall 1-day mortality rate in this cohort was 41.1%. (Table 5.).

Discussion

This is the first characterisation of out-of-hospital airway practices in AoNZ. Airway interventions were necessary in only a small minority (*n* = 4,592 (1.1%)) of patients who called for EMS assistance, but they were often seriously ill patients who suffered derangement of their vital signs and a high mortality rate. Of the patients receiving airway interventions, 43.5% (*n* = 2,153) patients had more than one airway intervention, with advanced airway interventions being

Table 2 – Characteristics of patients receiving ETI compared to all other airway interventions.

	Total n(%) n = 4,592	ETI n(%) n = 1,306	Other airway n(%) n = 3,286	P-value*
Age Group				
Missing data	2 (0%)			
0–18	365 (7.9%)	84 (6.4%)	281 (8.6%)	<0.001
19–64	2414 (52.6%)	730 (55.9%)	1684 (51.2%)	
65–84	1465 (31.9%)	445 (34.1%)	1020 (31%)	
> 85	347 (7.6%)	47 (3.6%)	300 (9.1%)	
Sex				
Missing data	5 (0.1%)			
Male	2788 (60.7%)	891 (68.2%)	1897 (57.7%)	<0.001
Female	1799 (39.2%)	415 (31.8%)	1384 (42.1%)	
Ethnicity				
Missing data	289 (6.3%)			
Māori	1048 (22.8%)	274 (21.0%)	774 (23.6%)	<0.001
Pacific Peoples	401 (8.7%)	148 (11.3%)	253 (7.7%)	
European	2567 (55.9%)	704 (53.9%)	1863 (56.7%)	
Asian & MELAA	287 (6.3%)	93 (7.1%)	194 (5.9%)	
Clinical presentation				
Cardiac arrest	2113 (46.0%)	971 (74.3%)	1142 (34.8%)	<0.001
Non-arrest Medical	1661 (36.2%)	160 (12.3%)	1501 (45.7%)	
Non-arrest Injury	818 (17.8%)	175 (13.4%)	643 (19.6%)	
Population setting				
Missing data	25 (0.5%)			
Rural	1084 (23.6%)	260 (19.9%)	824 (25.1%)	<0.05
Urban	3483 (75.8%)	1036 (79.3%)	2447 (74.5%)	
Socioeconomic Deprivation				
Missing data	235 (5.1%)			
1– Least deprived	547 (11.9%)	193 (14.8%)	354 (10.8%)	<0.05
2	653 (14.2%)	193 (14.8%)	460 (14.0%)	
3	780 (17.0%)	213 (16.3%)	567 (17.3%)	
4	939 (20.4%)	248 (19.0%)	691 (21.0%)	
5– Most deprived	1438 (31.3%)	395 (30.2%)	1043 (31.7%)	

*a p-value < 0.05 was considered significant. ETI = Endotracheal Intubation; MELAA = Middle Eastern, Latin American, African.

performed on 28.7% (n = 1,316) of patients. Our overall rate of successful ETI airway placement (89.4%, n = 1,168) is in line with international trends.[17–19] Out-of-hospital airway management in AoNZ differed by patient age, sex, ethnicity, rurality, cardiac arrest, and socioeconomic deprivation.

Patient characteristics of those receiving airway interventions from EMS

Patient characteristics of those receiving airway interventions were largely reflective of AoNZ population demographics and similar to those seen in North America, with the majority of patients being male, aged >45 years, New Zealand European (white), and found in urban settings.[6] The population of AoNZ is European (61%), Asian (15%), Māori (15%), Pacific (7%) and Non Stated/Other (2%).[20] When compared to these whole population proportions, our study indicates that European New Zealanders are underrepresented among airway management patients, while Māori are overrepresented. Reasons for this disproportion are likely to be multifactorial and may be in-part due to a higher proportion of critical illness such as cardiac arrest occurring in Māori.[21]

Out-of-Hospital cardiac arrest

Out-of-hospital cardiac arrest (OHCA) patients were major recipients of airway interventions, 46.0% of the whole patient cohort, attracting 74.3% (n = 971) of the total number of endotracheal intubations (DA-ETI and NDA-ETI combined). The AoNZ incidence of advanced airway interventions in OHCA (46.0%) is more than twice the reported North American rate (20.9%).[6] This could be due to differences in cardiac arrest management; in AoNZ, advanced airway interventions are permissible during OHCA, although minimal disruption to compressions is prioritised over any airway procedures.[22] In North America, it appears that iGels, LMAs, Combitubes, and other adjunct non-definitive airways may be favoured over ETI.[23]

Evidence to support the use of ETI vs a supraglottic airway in the setting of cardiac arrest is equivocal.[24,25] However, investigations of survival outcomes between airway types are impacted by ETI success rates.[26] The paucity of evidence supporting ETI in the setting of cardiac arrest, in conjunction with practitioner education, experience and procedural exposure led to ETI being removed from some paramedic practice in the setting of out-of-hospital cardiac arrest in the UK.[27,28]

Table 3 – Overall success rates of ETI according to clinical and demographic factors.

Procedure	Total Number of Patients	Successful n(%)	Odds Ratio (unadjusted)	95% Confidence Interval	p-value*	Odds Ratio (adjusted)	95% Confidence Interval	p-value*
Total ETI	1,306	1,168 (89.4%)						
Type								
NDA-ETI (Ref)	907	778 (85.8%)	1					
DA-ETI	399	390 (97.7%)	7.19	3.62–14.28	**<0.001***	3.31	1.35–8.09	**<0.05***
Age								
19 to 64 (Ref)	730	651 (89.2%)	1					
0–18 years	84	73 (86.9%)	0.81	0.41–1.58	0.53	0.55	0.25–1.19	0.13
65 to 84	445	402 (90.3%)	1.13	0.77–1.68	0.53	1.39	0.91–2.12	0.13
85 +	47	42 (89.4%)	1.02	0.39–2.65	0.97	1.28	0.48–3.44	0.63
Sex								
Female (Ref)	415	383 (92.3%)	1					
Male	891	785 (88.1%)	0.62	0.41–0.94	**0.02***	0.67	0.43–1.04	0.07
Ethnicity								
European (Ref)	704	630 (89.5%)	1					
Asian & MELAA	93	88 (94.6%)	2.07	0.81–5.25	0.13	2.14	0.83–5.54	0.12
Māori	274	244 (89.1%)	0.96	0.61–1.50	0.84	0.93	0.56–1.56	0.79
Pacific Peoples	148	125 (84.5%)	0.64	0.38–1.06	0.08	0.66	0.36–1.18	0.16
Aetiology								
Cardiac arrests (Ref)	971	838 (86.3%)	1					
Non-arrest Medical	160	157 (98.1%)	8.31	2.61–26.41	**<0.001***	2.95	0.75–11.62	0.12
Non-arrest Injury	175	173 (98.9%)	13.73	3.37–56.00	**<0.001***	11.78	1.48–93.94	**<0.05***
Population setting								
Urban (Ref)	1036	922 (89.0%)	1					
Rural	260	238 (91.5%)	1.34	0.83–2.16	0.23	1.18	0.7–2.01	0.54
Socioeconomic deprivation								
1 – Least deprived (Ref)	193	173 (89.6%)	1					
2	193	170 (88.1%)	0.85	0.45–1.61	0.63	0.84	0.43–1.64	0.60
3	213	189 (88.7%)	0.91	0.49–1.71	0.77	1.08	0.55–2.13	0.82
4	248	223 (89.9%)	1.03	0.55–1.92	0.92	1.34	0.68–2.63	0.40
5 – Most deprived	395	353 (89.4%)	0.97	0.55–1.71	0.92	1.17	0.62–2.22	0.63

*a p-value < 0.05 was considered significant. DA-ETI = Drug Assisted Endotracheal Intubation; ETI = Endotracheal Intubation; MELAA = Middle Eastern, Latin American, African; NDA-ETI = Non-Drug Assisted Endotracheal Intubation, Ref = reference group. Adjusted for: ETI type, age, sex, ethnicity, aetiology, population setting, and socioeconomic deprivation.

Patients presenting in cardiac arrest in our study had lower rates of ETI success compared to non-arrest patients, both medical and trauma (86.3% vs > 98%). Additionally, the first-pass success rate for cardiac arrest patients was 65.2%, meaning more than a third of patients will receive at least a second attempt. This suggests that paramedics could benefit from regular routine practice to maintain and develop skills. The use of NDA-ETI in the setting of cardiac arrest in AoNZ deserves review and perhaps further de-emphasis.

This is not an unusual finding: a prospective, multicentre, observational study conducted on pre-hospital physician intubations with a large cohort size noted that patients in cardiac arrest had significantly lower first-attempt success rates (80%) compared to those not in cardiac arrest and managed with DA-ETI (90%).[29] Reduced success may be associated with patient positioning for CPR or motion disturbance from compressions. Vomiting or regurgitation are also common in OHCA patients, compromising first-pass success rates.[30,31]

ETI success rates

There is debate regarding the risks and benefits of out-of-hospital airway management. This is particularly true of endotracheal intubation due to the dangers of unsuccessful (oesophageal) placement, with studies documenting oesophageal intubation rates ranging from 0.1% to 12%.[32,33] Unrecognised oesophageal intubation is now uncommon due to continual waveform end-tidal carbon dioxide monitoring. Mortality rates and incidence of complications from out-of-hospital intubation may relate to the experience, exposure, and training of the Paramedic or other medical professional performing the skill.[34,35] Patient demographics may also impact on ETI success, with ETI first-pass success rates lower for male patients than females, a pattern also seen overseas.[36]

Success rates for ETI are in line with international prehospital reports.[17–19] DA-ETI, the more complicated skill, always showed higher success rates than non-drug assisted intubation. DA-ETI facilitates intubation, and should perhaps be used when available.[17] This may be due to a training, experience, or teamwork effect. In AoNZ, DA-ETI is performed by more experienced practitioners with an emphasis on preparation and teamwork which supports optimal skill performance in stressful situations.[37]

New technology may assist with ETI placement, for example, video laryngoscopes are now available. Multiple randomised trials have found increased success rates using video laryngoscopy

Table 4 – Success rates of first-pass ETI according to clinical and demographic factors.

Procedure	Total Number of Patients	First Pass Successful n (%)	Odds Ratio (unadjusted)	95% Confidence Interval	P value*	Odds Ratio (unadjusted)	95% Confidence Interval	P value*
Total ETI	1294**	922 (71.3%)						
Type								
NDA-ETI (Ref)	906	581 (64.1%)	1					
DA-ETI	388	341 (87.9%)	4.06	2.91–5.67	**<0.001***	2.64	1.6–4.36	**<0.001***
Age								
19 to 64 (Ref)	721	523 (72.5%)	1					
0–18 years	83	60 (72.3%)	0.99	0.59–1.64	0.96	0.73	0.41–1.32	0.30
65 to 84	443	305 (68.8%)	0.84	0.65–1.08	0.18	1.09	0.81–1.46	0.58
85 +	47	34 (72.3%)	0.99	0.51–1.92	0.98	1.40	0.68–2.85	0.36
Sex								
Female (Ref)	412	320 (77.7%)	1					
Male	882	602 (68.3%)	0.62	0.47–0.81	**<0.001***	0.65	0.48–0.87	**<0.001***
Ethnicity								
European (Ref)	698	494 (70.8%)	1					
Asian & MELAA	93	74 (79.6%)	1.61	0.95–2.73	0.08	1.71	0.99–2.98	0.06
Māori	269	190 (70.6%)	0.99	0.73–1.35	0.97	1.01	0.71–1.45	0.95
Pacific Peoples	147	99 (67.3%)	0.85	0.58–1.25	0.41	0.94	0.6–1.45	0.77
Aetiology								
Cardiac arrests (Ref)	969	632 (65.2%)	1					
Non-arrest Medical	158	139 (88%)	3.90	2.37–6.41	**<0.001***	1.96	0.99–3.88	0.05
Non-arrest Injury	167	151 (90.4%)	5.03	2.96–8.57	**<0.001***	2.94	1.43–6.07	**<0.001***
Population setting								
Urban (Ref)	1030	715 (69.4%)	1					
Rural	254	199 (78.3%)	1.59	1.15–2.21	**<0.05***	1.46	1.01–2.1	**<0.05***
Socioeconomic deprivation								
1 – Least deprived (Ref)	191	134 (70.2%)	1					
2	192	133 (69.3%)	0.96	0.62–1.48	0.85	1.02	0.63–1.64	0.94
3	210	155 (73.8%)	1.20	0.77–1.86	0.42	1.29	0.8–2.07	0.30
4	245	179 (73.1%)	1.15	0.76–1.75	0.50	1.38	0.87–2.18	0.17
5 – Most deprived	392	272 (69.4%)	0.96	0.66–1.41	0.85	1.00	0.65–1.56	0.99

**12 cases unknown first pass success. *a p-value < 0.05 was considered significant. DA-ETI = Drug Assisted Endotracheal Intubation; ETI = Endotracheal Intubation; MELAA = Middle Eastern, Latin American, African; NDA-ETI = Non-Drug Assisted Endotracheal Intubation, Ref = reference group. Adjusted for: ETI type, age, sex, ethnicity, aetiology, population setting, and socioeconomic deprivation.

compared to direct laryngoscopy.[36,38,39] Our current findings are based predominantly on direct laryngoscopy. The increase in video laryngoscopy throughout AoNZ may improve first-pass success rates.

Incidence of clinically significant physiological changes and 1-day mortality

The incidence of significant physiological changes (hypotension, bradycardia, hypoxia) and death in the setting of airway interventions reveals the severity of physiological derangement in many of these patients. These were seriously unwell patients, as reflected by their mortality. Vital signs were all recorded after the airway intervention at any stage between scene and arrival at hospital. However, it cannot be determined in this study whether the physiological derangements were a complication of the airway intervention or due to the underlying patient condition, or both. Nevertheless, these rates of complication serve as a baseline for further investigation and future quality improvement.

Clinically significant physiological changes have been reported following airway interventions in a large American wide study (bradycardia (6%), hypoxia (20%) and hypotension (2%)).[6] Although the rates are very different from our findings, it appears that this study

Table 5 – Incidence of hypotension, bradycardia, hypoxia and 1-day mortality in patients receiving airway interventions.*

	Total number of patients	Low MAP*	Low systolic BP*	Bradycardia	Hypoxia	1-day mortality
	n	n (%)	n (%)	n (%)	n (%)	n (%)
Total	4592	562 (12.2%)	522 (11.4%)	1645 (35.8%)	703 (15.3%)	1889 (41.1%)
Airway type						
NDA-ETI	907	159 (17.5%)	165 (18.2%)	656 (72.3%)	200 (22.1%)	688 (75.9%)
DA-ETI	399	119 (29.8%)	108 (27.1%)	52 (13%)	103 (25.8%)	53 (13.3%)
Other Airway	3286	284 (8.6%)	249 (7.6%)	937 (28.5%)	400 (12.2%)	1148 (34.9%)
Aetiology						
Cardiac arrest	2113	264 (12.5%)	280 (13.3%)	1502 (71.1%)	350 (16.6%)	1620 (76.7%)
Non-arrest Medical	1661	170 (10.2%)	136 (8.2%)	86 (5.2%)	236 (14.2%)	215 (12.9%)
Non-arrest Injury	818	128 (15.6%)	106 (13%)	57 (7%)	117 (14.3%)	54 (6.6%)

*This table represents occurrences only, findings cannot be attributed to specific airway interventions as this paper did not investigate causation.
**MAP = Mean Arterial Pressure, BP = Blood Pressure.

focused solely on complications due to the airway intervention. A more recent UK study that investigated drug-assisted airway interventions in hospital, also found differing rates of clinically significant physiological changes: hypotension (26.3%), hypoxia (22.0%) and death (0.5%).[40] However, the in-hospital environment is much more controlled and resourced and therefore may not be directly comparable. Our findings point to the breadth of patient presentations requiring airway intervention and the often life-threatening conditions involved. Further research is needed to specifically define each complication and how these are related to airway interventions in AoNZ.

Limitations

This was a retrospective clinical chart review and therefore no causal links could be made. It was not possible to independently determine how many attempts at airway interventions were undertaken, or if indeed any airway intervention was performed as data is self-reported and not a mandated data field. However, it is an expectation that in accordance with the AoNZ EMS Clinical Procedures and Guidelines that all interventions performed are documented accurately. With a notable stigma attached to failed intubations, it is plausible that failure was recorded inaccurately. Similarly, there was no mechanism for study investigators to independently determine unrecognised oesophageal intubation. These limitations could lead to overestimation of success. The study included periods of the COVID-19 pandemic that may have impacted usual airway management, however during this time in AoNZ, active cases in the community did not exceed 200 per day.[41]

Conclusions

Out-of-hospital airway management practices and success rates in Aotearoa New Zealand (AoNZ) are comparable to those elsewhere. These results have determined the variables to be used as the AoNZ Paramedic Airway Registry data fields ongoing and demonstrated baseline outcomes in airway management for ongoing quality improvement using this registry.

CRediT author statement

CK, BD, CE contributed towards the study conception and design. CK, BD, VT contributed to data acquisition and analysis. CK, BD, VT, GH, EG, AS, CE, TS contributed towards data interpretation. CK, BD, VT, GH, JS drafted the manuscript. CK, BD, VT, GH, JS, BDit, EG, TS, AS provided critical appraisal of the manuscript. All authors gave final approval of the version to be published and agreement to be accountable for all aspects of the work.

Ethics approval

This study has been approved by the Northern B Health and Disability Ethics Committee. Reference: Aotearoa New Zealand, Paramedic Care Collection (ANZPaCC), 2022 FULL 13415.

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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