Review of Endotracheal Intubations by Ottawa Advanced Care Paramedics in Canada

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Abstract

Objectives. In the last several years, the National Association of EMS Physicians (NAEMSP) has called for better reporting on prehospital endotracheal intubation (ETI) and has provided guidelines and tools for better systematic review. We sought to evaluate the success of prehospital, non–drug-assisted ETI performed by Ottawa advanced care paramedics (ACPs) based on those guidelines. **Methods.** A retrospective review was conducted on ETI performed by Ottawa ACPs over a 25-month period to determine the overall success rate of ETI. To qualify our results, descriptive analysis was conducted on demographic data. The relationships between success rate, patient demographic data, and preintubation conditions were examined. **Results.** Overall success rate of ACP prehospital, non–drug-assisted ETI was 82.1% (95% confidence interval [CI]: 79.6, 84.3), representing a decreased value in comparison with the 90.7% of the previous study ($p < 0.001$). The study population comprised 1,029 intubated patients, the majority being adults (98.4%), with a mean age of 65.4 years (standard deviation [SD] 18.4). ETIs were successful for 64.6% (95% CI: 61.7, 67.5) of the first attempts; 79% of successful intubations were achieved within two attempts. ETI achievement was correlated with patients' age, with patients designated as vital signs absent (VSA), with those having a preintervention Glasgow Coma Scale (GCS) score of 3, and with those who were orally intubated ($p < 0.05$). Gender, weight, the nature (medical and trauma) of patient types, and locations of ambulance calls were found not to be related to the overall intubation success. **Conclusions.** This study reported the success rate of non–drug-assisted, prehospital ETI by ACPs in the Ottawa region. Our findings emphasize the importance of quality assessment for individual emergency medical services systems, to ensure optimum performance in ETI practice over time, and for intubation skill-retention training. **Key words:** paramedics; prehospital; endotracheal intubation

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Introduction

Endotracheal intubation (ETI) has been a part of acute, prehospital care for more than 20 years, and it is the most studied intervention in the prehospital literature.[1] The reported success rates for prehospital ETI fall within the range of 70% to 97%, depending on the patient types and whether or not paralytic agents were used during intubation.[2–6] Studies in the last several years have challenged the true effectiveness of prehospital ETI and the impact on patient survivial.[7–9] Thus, it is essential for each emergency medical services (EMS) system to conduct systematic reviews of its ETI practice and modify protocols to reflect the latest medical findings.

In 1997, Ottawa's newly formed EMS systems were reviewed, including the introduction of prehospital ETI; the results were reported in 2000.[10] The finding of a 90.7% ETI success rate became the benchmark of ETI success within the region, having a watershed effect on paramedic airway training, continuing education in workshops, and in operating rooms. The investigators of this study found that no systematic, longitudinal review of ETI skill retention in a single EMS system had been reported in the literature and felt that doing so would best respond to the National Association of EMS Physicians' (NAEMSP's) call for more systematic reviews of prehospital ETI practice in 2003. The association has provided guidelines and templates for uniform reporting.[11] This study was conducted to examine the prehospital ETI practice and relative success rate when ETI is attempted for patients of all ages within a Canadian EMS system.

Materials and Methods

This was a retrospective, observational study that examined all ETIs performed by a Canadian EMS system,

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specifically for the city of Ottawa and its surrounding areas between July 1, 2003, and July 31, 2005. The Ottawa Paramedic Service (OPS) is a provincially funded, municipally operated, public EMS system. This service employs over 300 paramedics who respond to more than 100,000 ambulance calls and file over 69,000 ambulance call reports (ACRs) annually. Ottawa paramedics serve both urban and rural communities with a catchment area of 2,756 square kilometers and a population of close to one million people. It is a two-tiered response system, composed of basic life support–trained primary care paramedics (PCPs) and advanced life support–trained advanced care paramedics (ACPs). The crews are configured with an ACP and a PCP in each vehicle; only ACPs are qualified to intubate patients. Ottawa paramedics operate under the Ontario Provincial Medical Directives and are supported by telephone contact with emergency physicians affiliated with a base hospital. Ottawa paramedics may perform an ETI under the following conditions: a patient requires ventilatory assistance that is not adequately provided by bag–valve–mask (BVM) technique, as defined by decreasing oxygen saturation, oxygen saturation <90%, or the deterioration of vital signs, such as an increasing respiratory rate, increasing heart rate, or decreasing blood pressure. Local ETI protocol does not permit drug-facilitated intubation, and ACPs are not trained to perform rapid-sequence intubation (RSI) in the field. Currently each ACP is allowed to attempt an ETI twice on a patient, while a second crew can make additional attempts should the patient's airway remain compromised.

All patients who were intubated by Ottawa ACPs during the designated 25-month period were considered for inclusion in the data for this study. Patients who were not intubated by Ottawa ACPs were excluded, as well as intubated patients transported between facilities and transported between provinces, and those attended to by a physician at the scene. Supraglottic airway devices (e.g., the laryngeal mask airway [LMA]) are available to Ottawa ACPs but are designated as rescue airway. For this reason, our exclusion criteria extended to patients treated with the LMA as the primary airway device.

Definitions of airway procedures were established prior to data extraction. We defined an *oral intubation attempt* as direct laryngoscopy, accompanied by the insertion of an endotracheal tube past the oropharynx. The insertion of an endotracheal tube past the nasopharynx met our parameters for a *nasal intubation attempt*. A *successful intubation* was defined as one with proper nasal or oral endotracheal tube placement, satisfying both clinical confirmation and capnometric confirmation. Paramedics were authorized to confirm tube placement on the scene when the protocol conditions of a standing, prehospital secure airway had been met (Fig. 1).

Sample size for this study was calculated by extrapolating the ETI success rates from the previous Ottawa study, and from the frequency of ETI in Ottawa. Since the study's primary objective was to determine the current regional ETI success, a power analysis ensured the required precision of the success rate estimates by using the Wilson score with continuity correction.[12] We estimated that a sample size of 1,000 patients would provide a 95% confidence interval of ±4% around an anticipated successful intubation rate of 90%, as recorded by the Rocca and colleagues study.[10]

Ambulance call reports are routinely submitted to and maintained by the Ottawa Base Hospital Program (OBHP) for quality improvement and with a compliance rate of >95%. We further cross-referenced the provincial EMS database to ensure all eligible ACRs were included in the study. Systematic chart reviews were then performed on all eligible ACRs by two independent off-duty paramedics, individually and separately. Data entry was verified between the two extractors to establish >90% agreement. The two principal investigators resolved conflicts in data extraction. Descriptive statistics were collected for the patient demographics of age, gender, and weight, the location of the ambulance calls, the call type (either *medical* [nontraumatic; patients with vital signs or vital signs absent, VSA] or *trauma* [patients with vital signs]), Glasgow Coma Scale (GCS) scores, and the route of airway (nasal vs. oral). Data were recorded in a computer database (Microsoft Access 2000, Redmond, WA) and analyzed using SPSS 16 (SPSS, Chicago, IL) statistical software. Student's t-test, chi-square, or Fisher's exact tests were used as appropriate. A p-valve of <0.05 was considered significant. This study and all the collected data had been preapproved by the Ottawa Hospital Research Ethics Board.

RESULTS

During the 25-month study period, 118,856 ACRs were filed to the OBHP. One hundred fifty Ottawa ACPs performed advanced airway procedures on 1,063 patients, 1,029 of whom were intubated by ETI. Thirty-four patients were intubated directly by LMA as a primary airway device and were excluded from this study. Most of the patients were adult (98.4%) and male (62.2%) (Table 1). The mean age was 65.5 years (ranging from 0 to 97 years) (age was not recorded for seven patients). Children constituted only a very small portion (1.6%) of all ETIs. Patients requiring ETI for medical reasons comprised 93% of the ambulance calls, 75% of which were due to cardiopulmonary arrest with VSA. Oral intubation was chosen on the first attempt for 877 (85.3%) patients, whereas nasal intubation was attempted in 151 (14.7%) patients.

Intubation was successful on the first attempt in 64.6% of cases. The likelihood of successful intubation

SET Protocol (Secure the Endotracheal Tube)
Ottawa Base Hospital

Placement		
P	Paramedic	Focus on doing this right, on getting the tube in.
R	Room	Give yourself every chance to succeed by ensuring you have good height, light and access to your patient. If you fail on the first attempt, look at this again. Move the patient if you have to.
E	Equipment	Before you suspend BVM ventilation to try for the tube, do you have all your equipment ready and checked. If you fail on the first attempt, what equipment change do you need to consider?
P	Patient	Do you need to place a tube at this time? Will you be able to? Assess the challenges to placing a tube correctly. Body type? Trismus? Vomiting? Is there a need to stabilize neck?
Confirmation		
Confirm ETT placement immediately after the patient has been intubated.		
Clinical signs of tracheal intubation		• Visualize the ETT through the vocal cords • Listen to chest while ventilating . . . equal, bilateral air entry? • Listen over gastric area while ventilating . . . gurgles? • Chest rise . . . equal, bilateral?
Technological signs of tracheal intubation		• Tube Check™ $\geq$ 40 ml of air aspirated using the • $ETCO_2$ return (levels will vary depending on patient cond.)[1] • SpO_2 return (level will vary depending on patient cond.)[2,3]

[1]'Normal' $ETCO_2$ levels: 30–43 mmHg, of little use in VSA patients.
[2]'Normal' SpO_2 levels: >92%.
[3]SpO_2 is an indicator of oxygenation not ventilation. In the setting of extratracheal intubation, SpO_2 may remain high initially if the patient was exposed to high-concentration oxygen prior to the intubation attempt.

FIGURE 1. Ottawa Paramedic Service endotracheal tube placement confirmation list. BVM = bag–valve–mask; $ETCO_2$ =end-tidal carbon dioxide; ETT = endotracheal tube; SET = secure the endotracheal tube; SpO_2 = oxygen saturation.

fell progressively for each attempt after the first. The median intubation attempt per patient was 2. Oral intubation was successful in 66.3% of patients, which was significantly more than for nasally intubated cases (54.9%) (relative risk 1.21, 95% confidence interval [CI]: 1.04, 140, $p < 0.05$). There were 184 failed intubation attempts for which the patients were then treated with alternate rescue airways: 72 cases with BVM, 57 cases by LMA, and 12 cases with other devices. Misplaced or displaced endotracheal tubes were noticed and repositioned in 15 cases (1.5%) during transport. Only one VSA patient with an incorrect tube placement was detected in the emergency department.

Overall success for ETI attempts occurred for 82.1% of the cases (Table 2); however, this was significantly lower than the 90.7% reported in the 1997 study[10] ($p < 0.001$). ETI was successful in 82.6% of the total group of medical patients, 86.3% of the subset of VSA patients, and 69.8% of the trauma patients. The success rates between adults and children were comparable, despite the small number of pediatric cases ($p = 0.19$).

The most successful intubation occurred in patients who were VSA and those with a preintervention GCS score of 3 (Table 3). The univariate analysis indicated that the patient's age, gender, and weight, the nature of patient type, and the location of ambulance calls were not significantly related to the overall intubation success.

DISCUSSION

For this study, the primary focus was to determine the overall success rate of prehospital, non–drug-assisted ETI in Ottawa. The regional proportion of 82.1% successful intubations was similar to that reported in the medical literature.[5] Simple comparison with results reported in other EMS systems may be problematic. Endotracheal intubation success varies by the patient's underlying disease and age, with paramedic training and experience, and by the use of RSI.[13] Age and patient pathology are among factors that have negatively impacted intubation success in some studies; they were found to be insignificant for

TABLE 1. Demographic Data for the Study Patients ($N =$ 1,029)

Age*, years	
Mean (±SD)	65.4 (±18.4)
Range	0–97
Age group	
Adult, no. (%)	1,013 (98.4)
Pediatric, no. (%)	16 (1.6)
Gender—male, no. (%)	640 (62.2)
Location, no. (%)	
Urban	913 (88.7)
Rural	116 (11.3)
Transported to hospital, no. (%)	515 (50.1)
Nature of ACR calls, no. (%)	
Medical	962 (93.5)
VSA	772 (75.0)
Trauma	66 (6.4)
Other	1 (0.1)

*Age was missing for seven patients. Subsequent review of those ambulance call reports identified them as adults.

ACR = ambulance call report; SD = standard deviation; VSA = vital signs absent.

TABLE 2. Summary of Endotracheal Intubation Success Rates for the Overall Study Group ($N = 1{,}029$)

	No. Successes	% Success Rate (95% CI)	Cumulative Success Rate (%)
No. ETI attempts			
First attempt	665	64.6 (61.6, 67.5)	64.6
Second attempt	148	40.7 (35.7, 45.8)	79.0
Third attempt	20	9.3 (6.1,13.9)	81.0
Fourth attempt	10	5.1 (2.8,9.1)	81.9
Fifth attempt	2	1.1 (0.3, 3.8)	82.1
Overall success	845	82.1 (79.7, 84.3)	82.1
Patient type			
Medical	795	82.6 (80.1, 84.9)	
VSA	671	86.3 (83.6, 88.5)	
Trauma	30	69.8 (54.9, 81.4)	
Adult	828	82.3 (79.8, 84.5)	
Pediatric	11	68.8 (44.2, 86.1)	
ETI route on first attempt			
Oral	581	66.3 (63.1, 69.4)	
Nasal	83	54.9 (47.0, 62.7)	

CI = confidence interval; ETI = endotracheal intubation; VSA = vital signs absent.

TABLE 3. Univariate Analysis of the Effect of Patient Characteristics on Endotracheal Intubation Success

Variable	Odds Ratio of Success on the First Attempt (95% CI)	p-Value
Patient characteristics		
Age	1.013 (1.006, 1.020)	<0.001
Gender (female vs. male)	0.85 (0.65, 1.10)	0.207
Weight	0.996 (0.991, 1.002)	0.169
Nature of emergency (medical vs. nonmedical)	0.66 (0.40, 1.08)	0.098
Region (rural vs. urban)	0.75 (0.51, 1.12)	0.152
VSA for the first attempt (yes vs. no)	1.60 (1.20, 2.14)	0.001
GCS score (>3 vs. 3)	0.54 (0.36, 0.81)	0.003
Methods of ETI (nasal vs. oral)	0.62 (0.44, 0.88)	0.008

CI = confidence interval; ETI = endotracheal intubation; GCS = Glasgow Coma Scale; VSA = vital signs absent.

our study population.[7–10] Ottawa's non–drug-assisted intubation protocol may have skewed paramedic patient selection toward VSA patients; therefore, it may contribute to higher intubation success. Conversely, our definition of an intubation attempt could potentially lead to possible underreporting. Each intubation attempt was defined as direct laryngoscopy with the insertion of an endotracheal tube as previously defined in Rocca and colleagues' study.[10]This helped to identify cases in which ETI was imminent and to avoid cases in which a paramedic might have simply used blade insertion to facilitate airway inspection and clearing. Whereas this study is consistent with Rocca and colleagues' definition of intubation, a lack of applied consensus in the literature causes potential discrepancy and must be considered when assessing ETI findings.

The local decrease in overall ETI success over the years was concerning. Our data set and methodology were not designed for in-depth analysis of possible causes for such a decrease. Nevertheless, dilution was a likely factor.[10,14–16] The number of Ottawa ACPs had increased from 48 in 1997 to 150 during the study period, while the number of ambulance calls that required advanced airway management remained constant. Despite efforts in providing optimum initial airway intubation training and continuing education sessions, skill retention remains troublesome for a procedure such as ETI, which is performed with relative infrequency. The prerequisite experience of six to 12 field intubations is a skill often unachievable within most Canadian EMS systems.[17] Issues with real patient practices are problematic because of cost, medical liability, and competition with other medical trainees. Improved simulation manikin training could improve procedure practices. The incorporation of supraglottic airways in patients with difficult airway management may also have a positive influence on ETI success.

We found little incremental success after two intubation attempts. This argues against further ETI attempts and for the use of an alternate airway management approach. Multiple attempts are associated with poor patient outcome.[18] Not only is scene time prolonged and transportation delayed, but with each attempt, new complications can occur, particularly hypoxia, cardiac arrhythmia, and physical injury to the oropharygneal airway, bleeding, and vocal cord edema, as reported by Wang and Yealy.[19] By limiting ETI attempts to two, both on-scene time and potential complications would be reduced. Less interruption of care would minimize patient morbidity and mortality. Despite the existing protocol and literature support, a significant amount of patients had been treated with multiple intubation attempts in the field. The strict adhesion to two ETI attempts per patient should be advocated.

In this study ETI success was correlated with route of intubation (oral versus nasal), patients without vital signs, and preintubation GCS scores of 3. Our findings are that the nature of the ambulance calls (medical, trauma), patient demographics, and patient geographic locations were not significantly contributing factors for failed ETI attempts. While not found to be significant, this study highlighted the rarity and difficulty of prehospital advanced airway intervention in young children.[20] Even though approximately 10% of calls were for pediatric patients, only 1% of the paramedic ETIs were for young children, thereby potentially masking the effects of age for ETI. Larger pediatric prospective studies are necessary for meaningful results of this subpopulation.

LIMITATIONS

The study was a retrospective chart review and, therefore, certain limitations are inevitable. Primarily, ambulance call data were not always recorded in real time. Reports were filed within the same day after each ambulance call; however, the quality of data recording was subject to recall bias. Not all the desired information for this study was available. The quality of chart completion and recording varied. No survival outcome measures were included. Insufficient data were available to assess the disease and trauma severity. Information on the indication for intubation was not given, and the decision to intubate was at the discretion of paramedics. The actual number of laryngeal visualizations before an intubation attempt was not recorded in the ACRs. In addition, there was no secondary mechanism to verify the confirmation of endotracheal tube placement in the field.

CONCLUSION

This retrospective review of ETI practice showed that the local ETI success rate was within the reported range of the literature; however, it has decreased from the 1997 review of the same population. In this study, ETI success was found to be most favorable for VSA patients, for unconscious patients, and by oral-route intubation. Consideration will be given to the improvement of ACP skill retention, training, and the introduction of supraglottic airway devices as the primary airway. The findings of this study reinforce the importance of the longitudinal analysis and routine quality reviews of prehospital ETI in any EMS system.

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