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Original Research

Procedural Sedation Intubation in a Paramedic-Staffed Helicopter Emergency Medical System in Northern Finland

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A B S T R A C T

Objective: Airway management to ensure sufficient gas exchange is of major importance in emergency care. Prehospital endotracheal intubation (ETI) by paramedics is a widely debated method to ensure a patent airway. ETI is performed with procedural sedation in comatose patients because of the regulation. The use of medications increases the rate of successful airway management compared with nonmedication ETI and may also improve outcomes in patients with traumatic brain injury. In the absence of an operative emergency physician and with long distances, paramedic-induced airway management may increase the survival of patients in selected scenarios. A paramedic-staffed helicopter emergency medical system in Northern Finland operates in a rural area without an emergency physician and paralytic medications and treats critically ill patients using basic or advanced life support ground units. The aim of this study was to evaluate the success rates of ETI performed by a small, appropriately trained, and experienced group of 8 nurse paramedics in an out-of-hospital setting.
Methods: The inclusion criterion for the study was an attempted intubation in patients with medical or traumatic indication for airway management by nurse paramedic.
Results: Fifty-one patients were treated with ETI. The first-pass success rate was 72.5%, the second-pass success rate was 94.1%, and the overall success rate was 100% within 4 attempts. The median on-scene time was 54 minutes, and there were no signs of aspiration during laryngoscopy or after successful ETI. The primary mortality rate was 11.7%.
Conclusion: The use of a rigid standard operating procedure for paramedic rapid sequence induction, paralytics, a video laryngoscope, and a gum elastic bougie might positively affect the ETI first-pass success rate. A follow-up study after these future modifications is needed. This small study suggests that intubation might be 1 option for airway management by an experienced nonanesthesiologist in Lapland.

In Finland, emergency medical services are organized by hospital districts. The system is publicly funded, including a helicopter emergency medical service (HEMS). Five of the HEMS units are based at university hospitals, whereas the unit operating in Northern Finland is located in Lapland's regional capital of Rovaniemi. The units operating out of university hospitals are staffed by an anesthesiologist with subspecialization in prehospital critical care together with a HEMS crewmember (either a paramedic or a firefighter) and a pilot, whereas the unit in Lapland is staffed with 2 nurse paramedics and 2 pilots. All nurse paramedics working in FinnHEMS 51 have experience in prehospital care for over 10 years. These flight nurse paramedics have a previous work background in road ambulances, and they all have a clinical degree in emergency nursing (bachelor of health care) from the University of Applied Sciences. They work in teams of 2.

Lapland is a large rural area, approximately 99,000 km^2. It covers 30% of Finland's surface area, and its estimated population density is 1.97 per km^2. In the winter season, Lapland is visited by a large number of tourists (in the 2016 winter season, there were 2.6 million booked hotel nights in Lapland). The paramedic-staffed HEMS unit had 1,438 missions dispatched in 2013, and the median flight time

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from the base to the scene was 29.5 minutes. FinnHEMS 51 used 2 Dauphin-type helicopters (AS365 N3 and N2) with 1 crew. The crew included 2 pilots and 2 nurse paramedics. In Lapland, anesthesiologists are only found in the Rovaniemi Central Hospital, which is a secondary-level small hospital. The nearest level 1 trauma center is located in Oulu, 200 km south of Rovaniemi.

Endotracheal intubation (ETI) is referred to as a golden standard of airway management but is associated with low success rates when performed by nonanesthesiologist emergency personnel.[1-5] Except in out-of-hospital cardiac arrest, ETI is performed with rapid sequence induction (RSI) when drug-assisted airway management is needed, which further limits its use in many countries to anesthesia-trained physicians only.[6,7] Procedural sedation with analgesic and anesthetic drugs is another option to perform advanced airway management with ETI or a supraglottic airway device (SAD).[8,9] SADs have been demonstrated to be easy to use in prehospital care, but these devices still possess insertion- and ventilation-related problems.[10,11] The use of medications increases the rate of successful airway management compared with nonmedication ETI.[12] The ETI rates in Finnish prehospital care are low,[13] and because of that, it may be difficult for advanced life support paramedics to gain enough experience in advanced airway management. However, in a small and selected group of paramedics, it may be possible to obtain good ETI success rates while also securing the necessary experience through intensive training and education.[14] The use of correctly selected medications, a capnometer, and a video laryngoscope may also improve ETI success rates and diminish unwanted clinical signs in patients.[15,16]

In Northern Finland, without prehospital operative emergency physicians, paramedics are forced to encounter and treat critically ill patients by themselves and hence must also secure the airways using advanced airway techniques. In traumatic brain injury, advanced airway management is a part of neuroprotection used to prevent secondary brain injury.[6,17] Long distances increase the need for airway management and may decrease survival in those patients with unsecured airways.

The aim of this study was to examine the success rates of ETI by a select group of nurse paramedics as well as the use of medications and the possible adverse reactions associated with prehospital airway management without a prehospital physician on scene. Our hypothesis was that ETI procedural success rates are high when the procedure is performed by a small, appropriately trained, and experienced group of nurse paramedics.

Methods

The study was approved by the Institutional Ethics Committee of Oulu University Hospital, Oulu, Finland. The study was a retrospective, observational study. Patient data were recovered from the national FinnHEMS database, the local HEMS unit's patient sheets, and the Lapland Central Hospital's and the Oulu University Hospital's patient registers during January 2013 to February 2014.

The inclusion criterion for the study was an attempted intubation in patients with medical or traumatic indication for airway management. The exclusion criterion was a prehospital physician on scene. Nurse paramedics assessed the patients' need for airway management according to local and national guidelines and contacted the region's prehospital physician on call who made the decision for airway management and the medications used in procedural sedation. Bag-mask ventilation was attempted in all patients. A bag-mask device equipped with an overpressure valve and supplied with a 15-L/min oxygen flow was used. An oropharyngeal airway was placed as needed to maintain a patent airway. If regurgitation were visible, a suction device was used.

In cases of cardiac arrest, the nurse paramedics were permitted to intubate the patient before consultation without medications. They were licensed to attempt the intubation a maximum of 3 times, after which alternative airway devices, primarily SADs, were instructed to be used. Endotracheal tube placement was confirmed with waveform end-tidal carbon dioxide ($ETCO_2$) monitoring and bilateral breath sounds on auscultation of the lungs. Nurse paramedics were licensed to use procedural sedation according to the decision of a prehospital physician. Local guidelines stated that in the case of using propofol, a norepinephrine infusion must be initiated before the intubation attempt in hypotensive patients. Norepinephrine was used at a concentration of 0.04 mg/mL and initiated with a bolus dose of 1 mL after propofol administration. Norepinephrine in boluses and infusion was the primary vasoactive used in hypotensive patients, and epinephrine boluses were used only in cardiac arrest.

Nurse paramedics' annual training consists of hands-on mannequin intubations in the operation room under an anesthesiologist's guidance. The annual number of intubations per nurse paramedic is 20 to 30, including training sessions. Nurse paramedics needed at least 20 live patient intubations per year to have a 1-year permit to intubate patients. If the annual number of the intubations were too low at the end of the year, they needed to fulfill the missing intubations in the operating room. In 2013 to 2014, nurse paramedics in FinnHEMS 51 operated without a standard operating procedure for sedation intubation, a video laryngoscope was only used as a bailout device, and ETIs were performed without a bougie. There was no protocol for procedural sedation, and the medications given depended highly on the recommendations of a consultant. RSI was not allowed because the local regulation banned the use of paralytic medications by nurse paramedics. At the time of data collection, there was no valid standard operating procedure for paramedic intubation.

Variables Studied

The data were documented and reported using an Utstein-style template including 23 core variables.[18] The following data were recorded: case ID, patient ID, times (alert, on scene, transportation begins, and in hospital), transportation form (ambulance or helicopter), receiving hospital, cause for intubation, preoxygenation, bag-valve-mask ventilation, number of laryngoscopy attempts, use of video laryngoscopy, bailout device, problems with intubation, use of nasogastric tube, use of medications (opiate, benzodiazepine, ketamine, or propofol), need for fluid resuscitation before intubation attempt, use of vasoactives (norepinephrine, epinephrine, ephedrine, or atropine), controlled mechanical ventilation after intubation, aspiration (before, during laryngoscopy, or after intubation), vital signs before and after intubation (blood pressures, Glasgow Coma Scale, pulse rate, oxygen saturation, and $ETCO_2$), chest X-ray, signs of aspiration, and mortality (primary).

Tabulation of the data was performed in Microsoft Excel 2010 (Microsoft, Redmond, WA). All data are expressed as medians (range) with the interquartile range (IQR) if not stated otherwise.

Results

Fifty-one patients were included in the study (Table 1). Intubation was performed successfully in 100% of the cases (51/51). The success rates were 72.5% (37/51) in the first, 21.6% (11/51) in the second, 3.9% (2/51) in the third, and 2% (1/51) in the fourth attempts, respectively. In the case that needed 4 intubation attempts, an SAD was used as instructed after the third attempt in a "cannot intubate—cannot ventilate situation," but ventilation was still unsuccessful because of anatomic deformities. There were no bailouts to bag-valve-mask ventilation. The video laryngoscope was only used in 3 cases and only once as a primary airway method. The most common problems during laryngoscopy were inadequate sedation of the patient and blood or gastric content in the larynx. Bailout devices were the SAD, McCoy laryngoscope, and video laryngoscope after the first unsuccessful intubation attempt.

Table 1
Demographics of Subjects

Variable	Study Group (*N* = 51)
Sex	
Females	14 (27.5)
Males	37 (72.5)
Age (years)	
< 18	3 (6)
> 18 y	48 (94)
Cause for airway management	
Out-of-hospital cardiac arrest	18 (35)
Unconscious	15 (29)
Trauma related	7 (13.7)
Intoxication	5 (10)
Seizures	4 (8)
Chest pain	2 (4)
Severe dyspnea	1 (2)
Other medications	
Norepinephrine infusion	40 (78)
Norepinephrine bolus	7 (14)
Epinephrine	13 (26)
Atropine	10 (20)
Ephedrine	3 (6)
Primary laryngoscopy device	
Laryngoscope	50 (98)
Videolaryngoscope	1 (2)
Primary bailout device	
McCoy	2 (3.9)
Video laryngoscope	1 (2)
SAD	1 (2)
Intubation	
First attempt	37 (72.5)
Second attempt	11 (21.6)
Third attempt	2 (3.9)
Fourth attempt	1 (2)
Overall success rate	51 (100)
Nasogastric tube	11 (22)
Controlled ventilation	37 (73)

SAD = supraglottic airway device.
Values shown are median (range) or n (%).

Regurgitation of gastric content was observed 12 times before the intubation attempt. Aspiration did not occur during or after intubation, and there were signs of aspiration in a chest x-ray after arrival to the hospital in 1 patient only.

The indications for airway management are presented in Table 1. The most common indications were cardiac arrest in 35% of the cases (18/51) and unconsciousness for unknown reasons in 29% of the cases (15/51). In 3 cases, patients were intubated because of an improperly seated SAD. Preoxygenation with high-flow oxygen was instigated in 80% of the cases, and the patients were bag-mask ventilated before intubation.

Patient vital signs were recorded before and after intubation. The data are presented in Table 2. Procedural sedation was used in 75% of cases (38/51). The most common combination of medications applied was propofol and an opioid (fentanyl, alfentanil, or oxycodone) in 60% of the cases (23/38) in which medications were needed before airway management. Opioids were used in 92% of the cases (35/38), propofol was used in 66% of the cases (25/38), S-ketamine in 24% of the cases (9/38), and benzodiazepines in 21% of the cases (8/38).

Fluid resuscitation was begun before airway management in 94% of the cases (48/51). The amount of fluid administered is unknown. Norepinephrine infusion was begun in 78% of the cases (40/51). Norepinephrine boluses without infusion were administered in 14% of the cases (7/51) and ephedrine boluses in 6% of the cases (3/51). In 20% of the cases (10/51), atropine was administered before intubation. Epinephrine boluses were mainly used in the patients suffering a cardiac arrest (13/20). Hypotension (< 90 mm Hg) occurred after intubation in 1 patient only.

Time stamps included the time to arrival on scene, the on-scene time, and the time to transportation. The median times were 40 minutes (IQR, 4-161 minutes) from dispatch to the scene, 54 minutes (IQR, 10-95 minutes) on scene, and 54 minutes (IQR, 5-178 minutes) from the scene to the retrieving hospital, respectively.

Controlled mechanical ventilation with the Oxylog 3000+ (Draeger, Lübeck, Germany) was initiated in 73% of the patients (37/51). Patients were transported to the hospital by air 16 times and in ambulance 29 times. Six patients were pronounced dead on scene. Nine patients were transported directly to the university hospital and 36 patients to the nearest central hospital. The primary mortality rate was 11.7% (6/51). Six patients survived to sign out from the university hospital.

Discussion

Our main findings were that the first-pass intubation success rate was 72.5% and 94.1% after a second attempt, without the possibility to perform RSI with muscle paralytics. The overall intubation success rate was 100% within 4 attempts. Furthermore, there was no visible aspiration from gastric content during or after intubation.

Others have reported similar success results. In a meta-analysis, the success rate for drug-facilitated intubation by nonphysician clinicians in the air medical setting was 94.6%.[12] More recently, Prekker et al[19] reported their experience on 7,500 paramedic ETIs with or without an RSI approach. The first-pass intubation success rate achieved by paramedics not using an RSI approach was 73% (n = 2,490). Paramedics were advised to consult with a physician before attempting ETI. With patients in cardiac arrest, paramedics were permitted to intubate before consultation. To use or not to use the RSI approach was based on decisions made by the paramedics.

The second-pass intubation success rate was 94% in the non-RSI group, with an ultimate success rate of 100%. However, the authors did not use the Utstein-style template for the uniform reporting of prehospital airway management. The common features between the study by Prekker et al[19] and ours are extensive training and high intubation frequency. Each paramedic performed at least 1 intubation per month. In the present study, the paramedics had 4 years of basic training, including theoretical training on airway management and intubations both in skill laboratories and operating rooms. Skills maintenance was performed with mannequin training and intubations in the operating room. The number of paramedics taking part in the trial was 8, and they worked in teams of 2. Accordingly, each of

Table 2
Vital Signs Before and After Intubation

	Before		After	
GCS	3 (3-13)	P	3 (3)	p
BP	140 (0-230)	mm Hg	117 (0-186)	mm Hg
HR	90 (0-140)	beats/min	78.5 (0-135)	beats/min
SpO_2	92 (0-100)	%	98 (0-100)	%
	First		Last	
$ETCO_2$	4.7 (1.3-12.9)	kPa	4.5 (1-7.4)	kPa

BP = blood pressure; ETCO2 = end-tidal carbon dioxide; GCS = Glasgow Coma Scale; HR = heart rate; SpO2 = oxygen saturation as measured by pulse oximetry.
Values shown are median (range) or n (%).

them would perform intubation in patients quite frequently. This rather high exposure may account for our high success rates.

In cardiac arrest, intubation conditions are usually better, whereas intubation success rates for trauma patients have been observed to be lower compared with nontrauma patients.[12] In the present study, 35% of the patients were intubated for cardiac arrest, but only 14% were trauma patients, which may partly explain our high success rates.

Methods for determining successful placement of prehospital intubation may have an effect on success rates. In the study by Silvestri et al,[20] the rate of unrecognized misplaced intubations in patients for whom paramedics used continuous $ETCO_2$ monitoring was 0, whereas the rate in the group for whom continuous $ETCO_2$ monitoring was not used was 23%. In our study, endotracheal tube placement was verified with continuous $ETCO_2$ monitoring. In addition, the use of $ETCO_2$ monitoring in major trauma patients after prehospital intubation has been suggested to reduce the rate of hyperventilation,[16,17] potentially limiting the risk of secondary brain injury.

Advanced airway management in the prehospital setting increases the on-scene time. A study from Australia reported that prehospital intubation was associated with a longer on-scene time in patients with moderate to severe traumatic brain injury but a shorter time spent in the emergency department before brain imaging. Prehospital intubation performed by a physician-staffed helicopter team resulted in a median scene time of 42 minutes.[21] The on-scene time was examined in a study published by Ringburg et al.[22] The average on-scene time for the HEMS team in their large study was shorter (35 minutes) than in the present study, but perhaps the higher degree of experience in invasive procedures by their anesthetist-staffed team influenced this. In our study, the median on-scene time was 54 minutes, but we did not record emergency department times. Other causes for longer on-scene times observed in this study may be the harsh environment of Lapland, the absence of a standard operating procedure for intubation, and the time elapsed during the consultation with the prehospital physician. To shorten the on-scene time, the airway management procedure should be planned, implemented, and trained for with the team completely. The proper use of adjuncts such as video laryngoscope and a gum elastic bougie and the use of different medication combinations with paralytic agents might also shorten the on-scene time.

Patients intubated in the prehospital setting may have a full stomach with its increased risk of aspiration. Aspiration of gastric content increases the risk of pneumonia, desaturation, and lung injury. An in-place intubation tube helps prevent aspiration. On the other hand, the intubation procedure has been reported to be associated with an increased risk of aspiration. The incidence of aspiration in prehospital trauma patients has been found to be 12% to 32%.[23,24] In the present study, only 14% of cases were trauma patients. Intubation in trauma patients is more challenging with lower success rates and possibly an increased risk of aspiration. Aspiration rates of 8%[23] and 12.7%[11] have been reported in out-of-hospital cardiac arrests and in trauma patients managed with an SAD. Casey et al[25] conducted a multicenter randomized trial among intensive care unit patients who received bag-mask ventilation before tracheal intubation. They reported an incidence of aspiration in 2.5% of bag-mask–ventilated patients and in 4% of nonventilated patients. In the present study, the operator-reported incidence of aspiration was 0, although signs of aspiration were later ascertained in 1 patient (1.96%) upon admission to the hospital.

Helm et al[26] reported on over 3,500 HEMS patient transports in Germany, 342 of which required on-site tracheal intubation. They reported a high incidence of blood, vomit, debris, or saliva complicating visibility of the trachea during the intubation maneuver. This is in line with our observation of blood or gastric content in the larynx being a major reason for difficult intubation.

In our study, paramedics working in HEMS were highly trained and educated. They were the only team allowed to perform prehospital ETI. We found that the overall success rate in our small patient cohort was 100%, without resorting to bailout devices such as SADs. This study suggests that a well-trained and experienced paramedic can achieve expert status in advanced airway management. In the present study, only the clinical competence of advanced airway management of HEMS nurse paramedics was assessed, whereas other themes of the role were not discussed.[27]

Adult learning is an active process that involves processing knowledge through interplay between existing skills and new information. Previous experience is a rich source for learning. Adult learners are motivated when learning integrates with the demands of their everyday work. Nurse paramedics in the present study were all experienced emergency operators. Their basic training includes intubations in the operating room under an anesthesiologist's guidance. All flight nurse paramedics working in HEMS units have experience in prehospital care for over 10 years. Securing the airway of critically ill patients is a real problem in prehospital care, and it can be argued that the emergency providers were motivated to learn new skills in a clinical environment.

There are several limitations to our study. First, this is an observational study with patient data collected retrospectively from a database and patient medical reports. Second, because prehospital data were self-reported and could not be independently verified, we cannot exclude that some information entered into the database and patient medical reports by nurse paramedics was inaccurate. On the other hand, the data were stored in the database and patient medical records at the time of treatment. Therefore, it can be concluded that most of the data were objective and most likely not biased. Third, we do not know how many out-of-hospital intubations each of the nurse paramedics performed individually. Also, this is a single-center study, so the results may not be generalizable to other systems, and the number of the patients treated was low. Finally, the intubation success rate is a short-term goal, and we could not assess whether intubations were beneficial to the eventual outcome of the patients.

Conclusion

This study suggests that experienced HEMS nurse paramedics may have a relatively good intubation success rate within 2 attempts without muscle paralytics in a mixed patient material. In areas where physician-staffed prehospital services are not available, an appropriately trained and experienced small group of nurse paramedics may attain acceptable success intubation rates. The use of a rigid standard operating procedures for intubation, the use of a video laryngoscope and a gum elastic bougie, and the use of paralytics might positively affect the ETI first-pass success rate. After the implementation of a protocol for paramedic RSI, a follow-up study should be performed to observe any changes in patient care, the first-pass success rate, and on-scene time.

References

1. Ruetzler K, Roessler B, Potura L, et al. Performance and skill retention of intubation by paramedics using seven different airway devices–a manikin study. *Resuscitation*. 2011;82:593–597.
2. Konrad C, Schüpfer G, Wietlisbach M, Gerber H. Learning manual skills in anaesthesiology: is there a recommended number of cases for anaesthetic procedures? *Anest Analg*. 1998;86:635–639.
3. Wang HE, Kupas DF, Hostler D, Cooney R, Yealy DM, Lave JR. Procedural experience with out-of-hospital endotracheal intubation. *Crit Care Med*. 2005;33:1718–1721.
4. Lossius HM, Roislien J, Lockey DJ. Patient safety in pre-hospital emergency tracheal intubation: a comprehensive meta-analysis of the intubation success rates of EMS providers. *Critical Care*. 2012;16:R24.
5. Denver Metro Airway Study Group. A prospective multicenter evaluation of prehospital airway management performance in a large metropolitan region. *Prehosp Emerg Care*. 2009;13:304–310.

6. Bernard SA, Nguyen V, Cameron P, et al. Prehospital rapid sequence intubation improves functional outcome for patients with severe traumatic brain injury. A randomized controlled trial. *Ann Surg*. 2010;252:959–965.
7. Peters J, van Wageningen B, Hendriks I, et al. First-pass intubation success rate during rapid sequence induction of prehospital anaesthesia by physicians versus paramedics. *Eur J Emerg Med*. 2015;22:391–394.
8. Bernard SA, Smith K, Porter R, et al. Paramedic rapid sequence intubation in patients with non-traumatic coma. *Emerg Med J*. 2015;32:60–64.
9. Schalk R, Byhahn C, Fausel F, et al. Out-of-hospital airway management by paramedics and emergency physicians using laryngeal tubes. *Resuscitation*. 2010;81:323–326.
10. Tanabe S, Ogawa T, Akahane M, et al. Comparison of neurological outcome between tracheal intubation and supraglottic airway device insertion of out-of-hospital cardiac arrest patients: a nationwide, population-based observational study. *J Emerg Med*. 2013;44:389–397.
11. Sunde GA, Brattebo G, Odegarden T, et al. Laryngeal tube use in out-of-hospital cardiac arrest by paramedics in Norway. *Scand J Trauma Resusc Emerg Med*. 2012;20:84.
12. Hubble MW, Brown L, Wilfong DA, et al. A meta-analysis of prehospital airway control techniques part I: orotracheal and nasotracheal intubation success rates. *Prehosp Emerg Care*. 2010;14:377–401.
13. Raatiniemi L, Länkimäki S, Martikainen M. Pre-hospital airway management by non-physicians in Northern Finland – a cross-sectional survey. *Acta Anaesthesiol Scand*. 2013;57:654–659.
14. Dyson K, Bray JE, Smith K, et al. Paramedic intubation experience is associated with successful tube placement but not cardiac arrest survival. *Ann Emerg Med*. 2017;70:382–390.
15. Ma Wayne, McDonnel M. Comparison of traditional versus video laryngoscopy in out-of-hospital tracheal intubation. *Prehosp Emerg Care*. 2009;14:278–282.
16. Helm M, Schuster R, Hauke J, et al. Tight control of prehospital ventilation by capnography in major trauma victims. *Br J Anaesth*. 2003;90:327–332.
17. Brazinova A, Maidan M, Leitgeb J, et al. Factors that may improve outcomes of early traumatic brain injury care: prospective multicenter study in Austria. *Scand J Trauma Resusc Emerg Med*. 2015;23:25.
18. Sollid SJM, Lockey D, Lossius HM. Prehospital advanced airway management expert group. A consensus-based template for uniform reporting of data from prehospital advanced airway management. *Scand J Trauma Resusc Emerg Med*. 2009;17:58.
19. Prekker ME, Kwok H, Shin J, et al. The process of prehospital airway management: challenges and solutions during paramedic endotracheal intubation. *Crit Care Med*. 2014;42:1372–1378.
20. Silvestri S, Ralls GA, Krauss B, et al. The effectiveness of out-of-hospital use of continuous end-tidal carbon dioxide monitoring on the rate of unrecognized misplaced intubation within a regional emergency medical services system. *Ann Emerg Med*. 2005;45:497–503.
21. Lansom JD, Curtis K, Goldsmith H, et al. The effect of prehospital intubation on treatment times in patients with suspected traumatic brain injury. *Air Med J*. 2016;35:295–300.
22. Ringburg AN, Spanjersberg WR, Frankema SP, Steyerberg EW, Patka P, Schipper IB. Helicopter emergency medical services (HEMS): impact on on-scene times. *J Trauma*. 2007;63:258–262.
23. Steuerwald MT, Braude DA, Petersen TR, Peterson K, Torres MA. Preliminary report: comparing aspiration rates between prehospital patients managed with extraglottic airway devices and endotracheal intubation. *Air Med J*. 2018;37:240–243.
24. Radu RR, Kaserer A, Seifert B, et al. Prevalence and in-hospital outcome of aspiration in out-of-hospital intubated trauma patients. *Eur J Emerg Med*. 2018;25:362–367.
25. Casey JD, Janz DR, Russell DW, et al. the PreVent Investigators and the Pragmatic Critical Care Research Group. Bag-mask ventilation during tracheal intubation of critically ill adults. *N Engl J Med*. 2019;380:811–821.
26. Helm M, Hossfeld B, Schäfer S, Hoitz J, Lampl L. Factors influencing emergency intubation in the pre-hospital setting—a multicentre study in the German helicopter emergency medical service. *Br J Anaesth*. 2006;96:67–71.
27. Braithwaite I, Steele A-M. "Flight nurses," or "nurses who fly"? An international perspective on the role of flight nurses. *Air Med J*. 2020;39:196–202.