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Clinical paper

Expertise in prehospital endotracheal intubation by emergency medicine physicians—Comparing 'proficient performers' and 'experts'☆

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ABSTRACT

Background: Training requirements to perform safe prehospital endotracheal intubation (ETI) are not clearly known. This study aimed to determine differences in ETI performance between 'proficient performers' and 'experts' according to the Dreyfus & Dreyfus framework of expertise. As a model for 'proficient performers' EMS physicians with a clinical background in internal medicine were compared to EMS physicians with a background in anaesthesiology as a model for 'experts'.
Methods: Over a one-year period all ETIs performed by the EMS physicians of our institution were prospectively evaluated. 'Proficient performers' and 'experts' were compared regarding incidence of difficult ETI, ability to predict difficult ETI, and decision for ETI.
Results: Mean years of professional experience were similar between the physician groups, but the median ETI experience differed significantly with 18/year for 'proficients' and 304/year for 'experts' ($p < 0.001$). 'Proficient performers' intubated 130 of their 2170 treated patients (6.0%), while 'experts' did so in 146 of 1809 cases (8.1%, $p = 0.01$ for difference). The incidence of difficult ETI was 17.7% for 'proficient performers', and 8.9% for 'experts' ($p < 0.05$). In 4 cases ETI was impossible, all managed by 'proficient performers', but all patients could be ventilated sufficiently. Unexpected difficult ETI occurred in 6.1% for 'proficient performers', and 2.0% for 'experts' ($p = 0.08$).
Conclusions: In a prehospital setting 'expert' status was associated with a significantly lower incidence of 'difficult ETI' and a higher proportion of ETI decisions. In addition, ability to predict difficult ETI was higher, although non-significant. There was no difference in the incidence of impossible ventilation.

1. Introduction

Endotracheal intubation (ETI) is an essential skill in emergency medical service (EMS) which was highlighted again by ILCOR 2010 guidelines.[1] However, potential serious risks are connected to the procedure, and just recently difficult ETI conditions have been shown to be associated with impaired patients' outcome.[2] Regular practice has been demonstrated to have an influence on ETI success in paramedic EMS systems at a relatively low level of practice (medians of 1/year,[3] 4.3/year,[4] 1/year,[5] and 12/year[6]) which led the guidelines to limit ETI to rescuers with adequate training and regular practice. In 2000 the guidelines quantified the amount of sufficient experience with 6–12 ETIs per year,[7] but subsequent guidelines did not give distinct figures any more.

However, the data cannot be transferred to physician-operated EMS systems, because EMS physicians typically are based on hospital departments, where they perform ETI with a higher frequency than during EMS shifts. On higher expertise levels prehospital ETI seems to be a safe procedure, but a study from France showed an influence of experience on prehospital ETI success for physicians, stating that 'seniors' had less difficulties than residents.[8] No further specifications were made but it can be concluded that a specific threshold for sufficient experience is not known. Therefore it is an open question for physician-operated EMS systems at what level of experience (or at what extent of training) the operator is competent to perform self-responsible ETI. The present study aimed to describe differences of ETI performance on distinct higher levels of expertise. From the same data set we already analysed factors predisposing for difficult prehospital ETI[9] which enabled us to control the two expert groups for this potential confounder.

To describe the development of medical expertise various theories have been introduced, but they predominantly focus on cognitive aspects or comprehensive competencies such as diagnostic reasoning.[10–12] Therefore, transfer to a single skill is limited.

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Only one of these theories, originally proposed by Dreyfus & Dreyfus,[13] has been adapted to the field of surgery and the development of skills.[10,14] According to this framework expertise develops within certain stages, starting from the levels of 'novice' and 'advanced beginner', and proceeding via 'competent' and 'proficient' performer to 'expert' and 'master'. It is proposed by Dreyfus & Dreyfus, that the specific stages are not to be thought as discrete steps, but as increments of a continuum.[13] Precondition to reach higher stages is the use of 'deliberate practice', which is characterised as a specific type of reflective practicing with the aim to excel previous competence levels.[15] Two further aspects may be incorporated into this framework: one is the shift from analytical (rule based) problem solving to pattern recognition,[16] which plays a specific role in the development from 'competent' to 'proficient performer' and 'expert'. The second aspect is related to the amount of time spent in the respective domain, which is commonly regarded to be at least 10 years or 10,000 h of deliberate practice for 'master' level.[15]

Stages of interest for prehospital emergency medicine are 'competent performers' with an expertise level equivalent to the end of residency training,[10] 'proficient performers' equivalent to the first half of specialty training, and 'experts' equivalent to a board specialist or consultant level where extensive deliberate practice may be applied.[17] Table 1 gives an overview of the Dreyfus & Dreyfus stages and an application to ETI competency levels and frequencies of practice.[10,13,15,16,18]

In our study 'proficient performers' were represented by EMS physicians with an in-hospital background in internal medicine; ETI practice was maintained by in-hospital emergency ETIs. The 'expert' group was represented by physicians with a background in clinical anaesthesiology with a day-to-day opportunity for deliberate practice.

We wanted to know, whether performance differences could be demonstrated between the two expertise levels to contribute data to the question how much training and regular practice is required to perform safe prehospital ETI. As primary outcome variable we defined the incidence of 'difficult prehospital ETI', which may be related to patients' outcome.[2] Secondary endpoints addressed (a) the use of technical aids and neuromuscular blocking agents, (b) the ability to predict 'difficult ETI' (i.e. the incidence of unpredicted difficult ETI), and (c) the probability of decisions for ETI.

2. Methods

The 'proficient' physician group ($n = 10$) originated from the department of internal medicine, mainly specialised in cardiology and pulmology. All 'proficient' physicians had a minimum clinical experience of 5 years, including one year of intensive care and a rotation to the emergency department (ED). Before starting EMS shifts they spent two weeks of airway management training in the operating room (OR) under supervision of experienced anaesthetists, including paediatric anaesthesia and the delivery room. Subsequently, only informal and irregular re-training was performed in the OR on discretion of the individual physician. Apart from EMS the main practice of the 'proficient' group was emergency ETI in intensive care units (ICUs), the ED, or during cardiac arrest alarms on peripheral wards. The 'expert' group consisted of anaesthetists ($n = 9$), also with a minimum of 5 years of clinical experience (including intensive care) before they entered EMS. Average practice of 2–3 ETIs per working day was obtained in all fields of anaesthesiology performed at a university hospital. This included the management of various difficult airway situations as in paediatric anaesthesia, ENT surgery, single lung ventilation, ICU, ED and peripheral ward emergencies.

From May 2004 to May 2005 all ETIs were prospectively analysed which were undertaken by the emergency physicians of the mobile intensive care unit and the helicopter emergency medical system based at our hospital (Benjamin Franklin Medical Center, Charité-University Medicine Berlin). Both EMS units serve a metropolitan area of approximately 400,000 inhabitants. Prehospital ETI procedures did not follow a formative protocol, but capnography was obligatory. After each ETI a questionnaire was filled out by the emergency physicians. They documented biophysical characteristics of patients, predisposing factors for difficult ETI, and ETI conditions (number of attempts and best visualisation of the laryngeal level as classified by Cormack and Lehane (CL)).[19] 'Difficult ETI' was defined by more than 3 attempts *or* difficult visualisation of the larynx (CL grade 3 or 4) merging the definitions of ASA guidelines[20] and a French working group.[21] Further data were collected for the use of technical aids, pharmacological facilitation, and whether difficult ETI had been predicted prior to the procedure. Finally, the physicians' experience was assessed in respect to total professional years, years of EMS practice, and the estimated annual total number of ETIs. No personal data were recorded.

2.1. Inclusion criteria

To assess the probability of ETI decisions all patients treated during the study period were included. In the rare cases when other EMS personnel had intubated the patient before arrival of physicians from the study site, it was proposed that study physicians would also have decided for ETI. To compare specific ETI conditions between the two physician groups only those cases were included where physicians from the study site had performed ETI, and where data sheets were complete. We did not gather patients' outcome data because sample size would not have sufficiently powered differences in morbidity and mortality.

2.2. Data safety

All EMS physicians were informed that the study purpose was to determine the incidence and conditions of difficult ETI, and that no personal data were recorded. The ethical committee of Charité – University Medicine Berlin approved the protocol.

2.3. Statistical analysis

Measurements are given as absolute percentages or as medians with a range from 25th to 75th percentiles.

"Sample size was calculated for a 15% higher incidence of 'difficult ETI' in the group of 'proficient performers', with an anticipated incidence of 5% for 'experts'. At a power level of 0.8 with an assumed alpha-mistake of 0.05 the minimum sample size to show a difference was calculated as $n = 88$ ETI attempts per group. This sample size could have possibly been reached within half a year, but since seasonal variations might affect ETI conditions (e.g. bright sunlight), we collected data over a whole year.

For statistical comparison of groups Chi-square-test was used if figures were above 50, and Fisher's exact test for figures below 50. Calculation was performed by SPSS, Version 13.0. Statistical significance was assumed at p-values below 0.05. Advice was given by the Institute for Medical Statistics of Charité – University Medicine Berlin.

3. Results

3.1. Group characteristics of emergency physicians

Physician groups did not differ statistically in respect to total years of practice and years in EMS, although the median differed by

Table 1
Theory of expertise development.

Expertise level	Phase of learning career (exemplary)	Organisation of knowledge and information[a]	Application to ETI competencies
Novice	Medical school: (first) clinical rotation	Exclusively rule based reasoning Information not prioritised	Knowledge of anatomy and indications for ETI Practical skill on manikin
Advanced beginner	Medical school: internship	Ability to sort information by rules 'Comparing' approach	ETI under optimum con-ditions is managed under supervision
Competent performer	(end of) Residency	Analytical and pattern recognition[b] of information Uncommon problems still require rule based reasoning	Autonomous management of standard ETI, needs help with difficult problems 5–10 ETIs/year 50 ETIs/career[c]
Proficient performer	'Clinical instructor'/specialist training	Ability to rely on pattern recognition; efficient organisation of information; able to extrapolate from a known situation to solve uncommon problems	Competent management of non-standard ETI; autonomous and safe management of emergency ETI 10–50 ETIs/year
Expert	Board specialist/consultant	Intuitive problem recognition and situational response Open to notice the unexpected	Numerous emergency ETIs have been performed with a variety of techniques/approaches 300–500 ETIs/year; 2500–5000 ETIs/career[d]
Master	Consultant educator/'clinical wisdom'	Exercises practical wisdom; beyond individual practice reflects in, on, and for action	>10,000 ETIs/career[d]

Modified from Dreyfus & Dreyfus[12] and Carraccio.[9]
It is proposed by Dreyfus & Dreyfus,[12] that the specific steps are not be thought as discrete stages, but as increments of a continuum.
[a] According to Ref. [9].
[b] According to Ref. [15].
[c] According to Ref. [17].
[d] According to Ref. [14].

6 years. Notably, the range of total years in practice was greater for internists and in consequence, internists had a longer experience in EMS. The number of prehospital ETIs for individual physicians did not differ statistically between the groups, again with a larger range for 'proficient performers'. The number of in-hospital ETIs could only be estimated. Estimation was easier for 'proficient performers' (with a median of 10/year) than for 'experts', where an approximation was made on the basis of 2.5 ETIs per working day, given 115 working days per year in the OR. For the resulting figure no statistical range can be given, but ETI figures substantially differ, according to expertise levels (see Table 2).

3.2. Patient characteristics according to physician groups

Patients' characteristics did not differ between the two groups of physicians in respect to gender, age, body mass index, and other predisposing factors for difficult ETI. Also, no statistical differences were present regarding underlying clinical conditions, although 'experts' intubated slightly more internal non-cardiac arrest patients (n.s.). For details see Table 3.

3.3. ETI conditions and difficult ETI

Details on numbers of attempts, ETI success, and visualisation of the larynx by CL grades are given in Table 4. Significant differences in favour of 'experts' were present for the best visualisation of laryngeal level and the incidence for difficult intubation (17.7% of attempts by 'proficient performers' vs. 8.9% by 'experts' ($p < 0.05$)).

In 4 cases ETI was not successful; all were treated by 'proficient performers'. However, all patients could be ventilated and oxygenated sufficiently by laryngeal mask, or bag-mask ventilation. No cannot-ventilate-cannot-intubate situation occurred.

The relation between ETI conditions and the number of *years of professional practice* did not show statistical differences, but a trend towards better ETI conditions with increasing experience was present for both expertise groups (see supplemental material online).

3.4. Technical and pharmacological facilitation

Technical aids were used as indicated in Table 4. 'Experts' made significantly more use of external manipulations and head

Table 2
Characteristics of EMS physicians: regular practice, years of practice, years in EMS (median; 25th–75th percentile).

	'Proficient performers'	'Experts'	*p*-Value
Years in clinical practice	14 (9–22)	8 (6–11)	n.s.
Years in EMS	9 (2–15)	3 (1–6)	n.s.
Individual in-hospital ETIs per year	10 (6–12)[a]	288[a]	n.a.[c]
Individual prehospital ETIs per year	8 (5 – 21)	16 (15–19)	n.s.
Total individual ETIs per year	18 (11–33)[b]	304[b]	n.a.[c]

[a] Figures estimated.
[b] Figures partly estimated.
[c] Statistical test not applicable.

Table 3
Patients' characteristics.

$n = 276$	'Proficient performers'	'Experts'	p-Value
Age (median)	66	65	n.s.
Gender female	37% (48/130)	39% (57/146)	n.s.
Body weight (median)	80	80	n.s.
Body mass index (median)	26.4	26.6	n.s.
Biophysical conditions of patients			
Short neck	23.0% (30/130)	26.7% (39/146)	$p = 0.5$
Facial/neck injuries	4.6% (6/130)	4.7% (7/146)	$p = 0.9$
Body mass index > 30	22.3% (29/130)	26.7% (39/146)	$p = 0.4$
Conditions on scene			
Restricted space	29.0% (38/130)	28.7% (42/146)	$p = 0.9$
Cervical spine protection	8.4% (11/130)	8.2% (12/146)	$p = 0.9$
Underlying conditions of patients			
Cardiac arrest	63.8% (83/130)	63.6% (93/146)	$p = 0.9$
Internal (non-cardiac arrest)	18.4% (24/130)	28.0% (41/146)	$p = 0.08$
Major trauma	7.7% (10/130)	2.7% (4/146)	$p = 0.1$
Severe head injury	10.0% (13/130)	5.4% (8/146)	$p = 0.2$

positioning. The use of neuromuscular blocking agents (NMBAs) and sedation was compared only for non-cardiac-arrest patients (because muscle relaxation was unlikely to be given in cardiac arrest). 'Proficient performers' utilised NMBAs in 54% of their non-cardiac-arrest patients, in all others cases only a sedative was given. In contrast, 'experts' applied NMBAs in nearly all of their respective patients ($p < 0.01$, see Table 4). In non-cardiac-arrest situations with difficult ETI 'proficient performers' did not use NMBAs in 5 of 10 cases compared to 'experts' with 0 of 2 cases. Due to the small sample size a statistical difference could not be demonstrated.

3.5. Prediction of difficult ETI

As shown in Table 5 difficult ETI prediction differed significantly between the expertise groups in respect to positive prediction of non-difficult ETI ($p < 0.01$). For the most relevant situation regarding patients' safety, the incidence of un-predicted 'difficult ETI', statistical significance was not reached (6.2% vs. 2.1%, $p = 0.06$).

3.6. Probability of decision for ETI

Overall, for 7.7% (305 of 3979) of the patients ETI was attempted. 5 of these were intubated by other EMS personnel before arrival of study physicians, and 24 data sets were incomplete. In consequence, 276 ETIs could be analysed for comparison between the two expertise groups. 'Proficient performers' decided for ETI in 6.0% of their cases (130 of 2170 patients), while 'experts' did in 8.1% (146/1809). Chi-square-test showed a significant difference ($p = 0.01$).

4. Discussion

4.1. ETI conditions and incidence of difficult ETI

Aim of this study was to compare ETI performance of two expertise levels of EMS physicians. As the main finding the incidence of difficult ETI (primary study endpoint) was about half as high in the 'expert' group if compared to 'proficient performers' (8.9% vs. 17.7%; $p < 0.05$). Also, other indicators of technical mastery revealed a superior performance of the 'expert' group (e.g. visualisation of the larynx). Obviously higher ETI experience is the most likely reason for this difference, but looking into it more closely, certain behaviours of 'experts' might explain their better performance. Paradoxically, 'experts' made significantly more use of pharmacological and technical facilitations (Table 4), although they might have been less dependent on respective interventions. As an example 'experts' used NMBAs in nearly all of their non-cardiac-arrest ETIs in contrast to 'proficient performers' whose

Table 4
Comparison of ETI conditions in respect to expertise stages ('proficient performers', 'experts').

	Expertise group		Statistical difference
	Proficient performers	Experts	
Best visualisation of laryngeal level			
CL[a] grade 1	43.1% (56/130)	61.6% (95/146)	$p < 0.01$
CL[a] grade 2	40.0% (52/130)	25.3% (37/146)	$p < 0.01$
CL[a] grade 3	14.6% (19/130)	8.9% (13/146)	$p = 0.1$
CL[a] grade 4	2.3% (3/130)	0.7% (1/146)	$p = 0.3$
Number of ETI attempts			
$n = 1$	84.6% (110/130)	89.0% (130/146)	$p = 0.3$
$n = 2$	10.8% (14/130)	8.9% (13/146)	$p = 0.7$
$n = 3$	2.3% (3/130)	2.1% (3/146)	$p = 0.8$
$n > 3$	2.3% (3/130)	0	$p = 0.2$
Success rate	96.7% (126/130)	100.0% (146/146)	$p = 0.1$
Incidence of difficult ETI	17.7% (23/130)	8.9% (13/146)	$p = 0.05$
Technical/pharmacological facilitation			
Optimized head positioning	9.2% (12/130)	42.4% (62/146)	$p < 0.01$
Extra-laryngeal manipulation[b]	10.7% (14/130)	23.2% (34/146)	$p < 0.01$
Gum elastic bougie	35.3% (46/130)	36.9% (54/146)	$p = 0.8$
Sedatives only[c]	46.0% (16/35)	4.0% (2/50)	$p = 0.03$
Neuromuscular blocking agents[c]	54.0% (19/35)	96.0% (48/50)	$p = 0.01$

[a] CL: Cormack & Lehane grade.
[b] For example: 'backward-upwards-right-pressure'.
[c] Primary cardiac arrest cases excluded.

Table 5
Prediction of ETI conditions.

	Conditions actually found			
	Proficient performers ($n = 130$)		Experts ($n = 146$)	
	Non-difficult	Difficult	Non-difficult	Difficult
Predicted conditions				
Non-difficult	68.5%[a] ($n = 89$)	6.2%[b] ($n = 8$)	83.6%[a] ($n = 122$)	2.1%[b] ($n = 3$)
Difficult	13.8% ($n = 18$)	11.5% ($n = 15$)	7.5% ($n = 11$)	6.8% ($n = 10$)

[a] Non-difficult ETI, correctly predicted; difference: $p < 0.01$.
[b] Unpredicted 'difficult ETI'; difference: $p = 0.06$.

strategy was only sedation in half of their respective cases. Accordingly, it has already been shown for emergency ETI in an ED setting that the addition of NMBAs to sedatives significantly lowers complication rates.[22] As a second example interventions to optimize the position of head and larynx were performed significantly more often by 'experts', indicating that 'experts' put more effort in the best possible visualisation. These expert behaviours suggest that not only superior skills but also knowledge is responsible for their improved performance. In consequence, the implementation of a standard algorithm including specific interventions might improve ETI success and minimise complications. The usefulness of respective algorithms has been shown recently for emergency ETI in ICUs,[23] and for defined 'difficult prehospital ETI'.[24]

Nonetheless, the findings of superior technical skills can only be regarded as surrogates for patients' safety, since stronger outcome parameters as cannot-ventilate-cannot-intubate situations, or morbidity and mortality were not sufficiently powered by our study. Although Jabre et al.[2] have shown difficult ETI to be an independent predictor of patients' death (for non-cardiac arrest cases), to our opinion it remains open to what extent difficult ETI is attributed to the operator. For our study cohort it can be summarised, that we were unable to show any situation of impossible ventilation for an EMS covering a population of 400,000 over a one-year-period, suggesting that 'proficient performers' did not compromise patients' outcome to a relevant degree.

4.2. Probability of ETI decision

'Experts' performed ETI with a significantly higher probability than 'proficient performers'. In respect to different expertise levels this is an important finding, because it may well reflect a typical expert strategy. On the one hand it can be speculated, that 'experts' feel more competent in the procedure, thus deciding for ETI with a lower threshold. This point is strongly supported by the higher ability of 'experts' to predict difficult ETI (Table 5), even though the difference slightly failed to reach statistical significance. Notably, 'experts' performed ETI in a higher proportion of internal non-cardiac arrest patients (n.s.), which might also reflect their specific decision making.

On the other hand, this finding could be interpreted as taking more risks. This may raise concerns in the light of data indicating increased morbidity and mortality after difficult ETI.[2] However, it is a known characteristic of experts to activate more effective procedures to meet complications.[12,25] An example might be the dose reduction for induction of anaesthesia to prevent severe hypotension in specific patients. Whether higher risks of ETI are weighed out by superior performance remains speculation.

The reason of 'proficient performers' behaviour to decide for ETI with a lower probability may only be speculated on. Whether they actively withheld ETI, especially in cases of suspected difficulties, or simply did not see the need for it cannot be answered. In cases of suspected difficult airway, withholding ETI if not mandatory could as well be the more beneficial approach for this level of expertise. At last, ETI is not to be regarded as an isolated skill, but rather as a part of bundle of interventions which should be addressed as an integrated competency.[26]

4.3. Appropriateness of expertise model

The median number of ETIs per year for the 'proficient' group was 18 (11–33), supporting their allocation to the respective level in the Dreyfus & Dreyfus framework. This figure is similar to a recent report from the French EMS staffed with a heterogeneous physician group,[24] and well above the amount which was recommended by the ILCOR 2000 guidelines. The figure is also well above those reported from paramedic-based EMS systems. Therefore, ETI competence in paramedic-based systems might be described at a level of 'competent performance' in the Dreyfus & Dreyfus framework.[13]

Sorting the anaesthetists in this study into the category of 'experts' also seems reasonable, as ETI experience of 'experts' was more than ten-fold higher than in the 'proficient performer' group. Additionally, ETI is perceived as a core competency in anaesthesiology, thus providing a natural trigger for deliberate practice. Looking at total professional years 'experts' had slightly less experience than the 'proficient performer' group. As our results also indicate that with increasing years in EMS a tendency towards better performance was seen, results would have been even more pronounced if they had been corrected for that effect.

In summary, the authors feel that the proposed expertise model appropriately describes the physician groups in this study.

4.4. Implications for training

Our data were unable to show inferiority of 'proficient performers' on a level of patient safety. Nonetheless, one should pose the question, what could be learned from 'experts'. First, taking into account the higher ability to predict difficult ETI by 'experts', it could be beneficial to assess predisposing factors for difficult ETI before the procedure (such as short neck, high BMI, or restricted space on scene).[9] Second, the use of technical and pharmacological facilitation could be incorporated into a specific algorithm in order to minimise complications.[24] Third, a cognitive approach to more effective training strategies could promote the use of deliberate practice by reflection on specific case management[17] thereby strengthening pattern recognition approaches.[16] All three respective aspects should be incorporated into regular re-training programs, perhaps involving training in the OR with peer supervision by experts.

Looking at the expertise level below 'proficient performers' (i.e. 'competent performers') it seems reasonable to restrict prehospital ETI more clearly and advocate the use of alternative supraglottic devices. This point could further be supported by the absence of sound evidence for the benefits of prehospital ETI.[27]

4.5. Generalizability

The patient sample and the prehospital setting were well defined and did not differ between the two expertise groups. Also, both expertise groups were well defined and distinctly separated. Therefore, we feel that results might be valid for most physician-operated EMS systems. There might even be some transferability to ED situations, at least during on-call shifts (where higher expertise is not easily available).

4.6. Limitations

The data represent a single centre situation and the sample size was not sufficient to power differences in patients' outcome.

As another limitation data acquisition had to rely on physicians' self reports. Therefore, a potential reporting bias might be discussed due to lower expertise of 'proficient performers', who might have been less competent in describing ETI conditions. We tried to minimise this effect by using only descriptive data from the data sheet, where for instance CL grades were depicted to compare them with the actual finding. Motivation to give more favourable ratings seemed to be low due to the fact that physicians knew that the study purpose was not to evaluate their individual performance.

As a further limitation standardised independent reassessment of ETI conditions at hospital arrival was not possible due to the variation of admission hospitals and admission teams. Accordingly, also no independent assessment of ETI decisions was possible.

Finally, estimations of in-hospital ETI experience are subject to uncertainty. However, this point is more relevant for the 'expert' group, since for 'proficient performers' half of their ETI volume was empirically measured as prehospital ETIs.

5. Conclusion

On the level of 'experts' according to the Dreyfus & Dreyfus framework of expertise difficult prehospital ETI occurs approximately half as often as on the level of 'proficient performers'. Also other indicators for technical mastery are significantly superior at 'expert' level. However, in respect to stronger outcomes of patients' safety (cannot-ventilate-cannot-intubate situations) no significant difference between the different expertise levels could be demonstrated for an EMS serving 400,000 inhabitants over a one-year period.

As another important result the study describes expert behaviour on an empirical basis. 'Expert' emergency physicians were more likely to decide for ETI than 'proficient performers', and made more use of technical and pharmacological facilitation.

Findings might have implications for ETI training requirements.

Conflict of interest statement

None declared.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi:10.1016/j.resuscitation.2011.10.011.

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