
Original Contributions

EFFECT OF PARAMEDIC EXPERIENCE ON OROTRACHEAL INTUBATION SUCCESS RATES

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□ **Abstract**—This study's objective was to determine the effect of paramedic experience on orotracheal intubation success in prehospital adult nontraumatic cardiac arrest patients. This retrospective study analyzed all attempted intubations of prehospital adult nontraumatic cardiac arrest patients between January 1, 1997 and April 30, 1997 in an urban, all ALS service. Data were abstracted from EMS reports and intubation data forms. Variables included months of experience, number of patients in whom intubation was attempted, number of intubation attempts, success per attempt, and success per patient. Ninety-eight paramedics performed 909 intubations on 1066 cardiac arrest patients, yielding an intubation success rate of 85.3%. The median months of experience was 59.5 (Range 5–223). The median number of patients in whom intubation was attempted per paramedic was 10 (Range 1–36). The mean intubation success rate per paramedic was 80.6% (\pm 22.4, 95% CI 76.1, 85.1). There was significant correlation between total number of patients in whom intubation was attempted and intubation success rate ($p < .001$, $R = 0.32$). There was no correlation between months of experience and intubation success rate. In conclusion, the number of patients in whom intubation was attempted per paramedic was significantly correlated with the intubation success rate. Months of experience per paramedic had no signifi-

cant correlation with intubation success rate. © 2003 Elsevier Inc.

□ **Keywords**—emergency medical services; intubation; airway; paramedic; cardiac arrest

INTRODUCTION

Paramedics have consistently demonstrated to the medical community that they can perform endotracheal intubation with good success rates (1–3). Orotracheal intubation is now considered the cornerstone skill of advanced airway management for paramedics. For Emergency Medical Services (EMS) medical directors, assessing the intubation ability of their paramedics is a critical component of their position. Previous studies have demonstrated that cardiac arrest survival rates are generally lower in communities where paramedics are not allowed to intubate (4–6). Improved outcomes for trauma patients who were intubated in the field also have been previously published (7–9). Additionally, intubation success rate is one of the more objective measures that medical directors can use to monitor the quality of their EMS systems (10,11).

Intuitively, health care providers have assumed that more experienced paramedics should be able to perform

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orotracheal intubation with greater success than less experienced paramedics. Few previous studies, however, have examined whether this experience is a measure of seniority or the frequency of skill usage. The EMS literature yields conflicting results on the relationship between paramedic experience and intubation success (2,12,13).

The primary objective of this study was to determine if there was any correlation between paramedic experience and orotracheal intubation success in out-of-hospital nontraumatic cardiac arrest patients.

MATERIALS AND METHODS

This retrospective study was conducted in a midwestern, urban EMS system. The initial responders were Emergency Medical Technicians (EMTs) and First Responders from the local Fire Department. The Fire Department responded to all cardiac arrest calls and was equipped with Automated External Defibrillators. The ambulance system is a single tier, all Advanced Life Support (ALS), public utility model service providing exclusive emergency and nonemergency care and transport within the city limits. During the study period, the ambulance service transported over 60,000 patients per year and was staffed using a split crew of EMT/Driver and a single Paramedic/Attendant. Paramedics in this system are licensed by the City Health Department, the State Bureau of Emergency Medical Services, and have National Registry certification.

Medical oversight of the system was performed by the City Health Department's EMS Section. This section and the Quality Improvement (QI) Manager for the ambulance service routinely collect data on all attempted intubations.

Inclusion criteria included all adult medical cardiac arrest patients intubated by full-time paramedic field personnel between January 1, 1997 and April 30, 1999.

Intubation data for every adult (age > 15 years) nontraumatic cardiac arrest patient were extracted by the QI Manager from state ambulance report forms and intubation data sheets completed by the treating paramedic. The receiving Emergency Physician signed the intubation data sheet verifying endotracheal tube placement. An orotracheal intubation attempt was defined as any time the laryngoscope blade was advanced past the teeth in an attempt to intubate the patient. The EMS system allowed nasotracheal intubation for certain populations of patients, none of whom were included in this study. The system uses ETCO₂ detectors; however, there were no esophageal detection devices used during the study period. Rapid sequence intubations are not performed.

Paramedics were excluded from the study if their primary role was anything other than a field paramedic (e.g., dispatchers, administrative personnel, and field supervisors). Paramedics were also excluded if they did not work in the system during the entire study period. For each paramedic, months of experience was defined by calculating the date that the paramedic was first state licensed to the starting date of this study; this time included any prior employment in other EMS systems and any evaluation or probationary time.

Data were entered into a database (Microsoft Access™, Redmond, WA) and analyzed using SPSS 10.0 (SPSS™ Chicago, IL) statistical software. Intubation data between January 1, 1997 and April 30, 1999 (28 months) were analyzed. Descriptive statistics were performed on months of experience, number of patients in whom intubation was attempted, number of attempts, success per attempt, and success per patient. Pearson correlation was performed comparing the paramedic's intubation success rate with months of experience and the success rate with the number of patients in whom intubation was attempted per paramedic. A *p* value of < .05 was considered significant.

The University of Missouri—Kansas City Adult Health Sciences Institutional Review Board exempted this study from review.

RESULTS

During the study period, 98 paramedics attempted to intubate a total of 1345 cardiac arrest patients. There were 1105 adult, nontraumatic cardiac arrests during the study period (82.2%), of which 1066 (96.5%) met inclusion criteria. Thirty-three cardiac arrest patients had intubations performed by paramedics that did not fit inclusion criteria (i.e., not full-time field personnel). Six cardiac arrest patients (0.6%) did not have an intubation attempt performed. Of the 1066 study patients, 909 were successfully intubated, yielding an overall intubation success rate of 85.3%.

The paramedic study population had a median of 59.5 months of experience (Range 5–223) (Figure 1). During the study period, there was a median of 10 patients in whom intubation was attempted per paramedic (Range 1–36) (Figure 2). The average number of intubation attempts per paramedic was 1.3 (Range 1.0–2.75). The mean intubation success rate per paramedic was 80.6 (± 22.3; 95% CI 76.1, 85.1) (Figure 3).

There was a significant correlation between the total number of patients in whom intubation was attempted per paramedic and intubation success (*p* < .001, *R* = 0.324) (Figure 4). There was no significant correlation

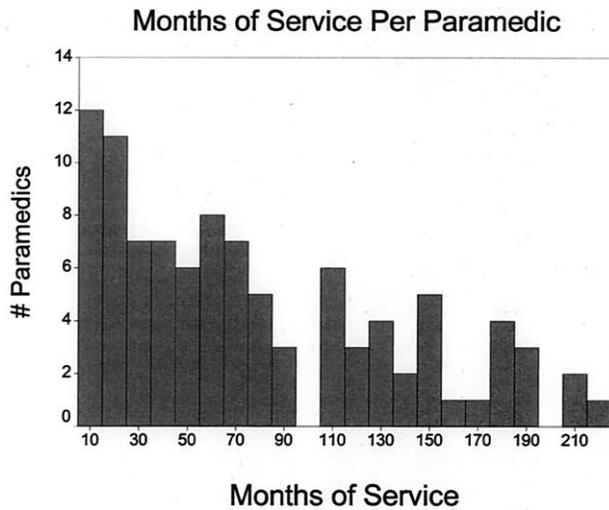


Figure 1. Months of experience for paramedic study population.

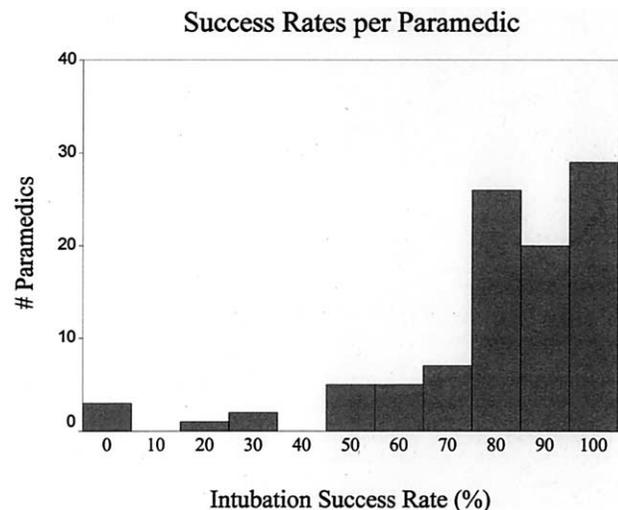


Figure 3. Mean intubation success rate per paramedic.

between months of experience per paramedic and intubation success ($p = .241$, $R = 0.120$) (Figure 5).

DISCUSSION

The purpose of this study was to evaluate the relationship between paramedic “experience” and the success rate of orotracheal intubation in adult nontraumatic cardiac arrest patients. This study was unique for several reasons. First, in accounting for experience, the number of months was calculated from the date that the paramedic was first licensed as a paramedic, provided that the person had been working continuously as a paramedic.

This accounted for any experience a paramedic may have had before working in our system.

Second, only cardiac arrest patients were used in the study design. This was done to control the intubation scenario and patient selection as much as possible. Including intubations from all clinical scenarios in the study design could potentially confound the effect of experience on intubation success. An earlier study in our system found that comparing individual paramedic intubation success rates using all intubations was misleading and there may be special causes for low outliers, such as patients with traumatic injuries, pediatric patients, and medical noncardiac arrest patients (14).

Using all intubations when comparing success rates

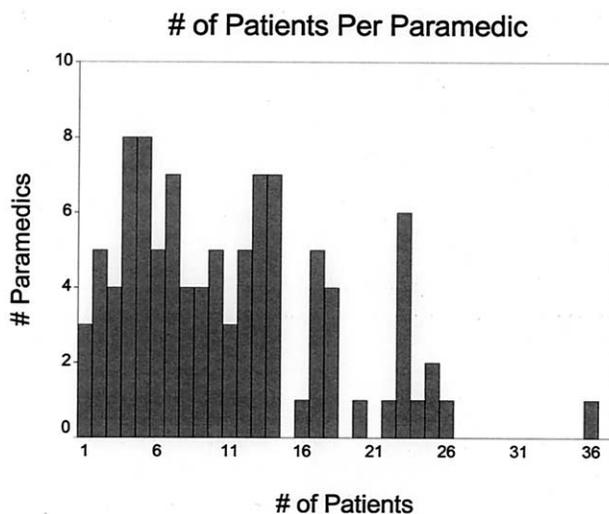
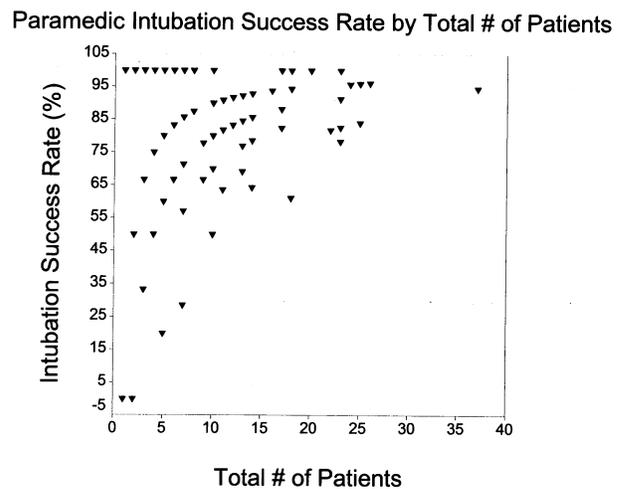


Figure 2. Number of patients in whom intubation was attempted per paramedic.



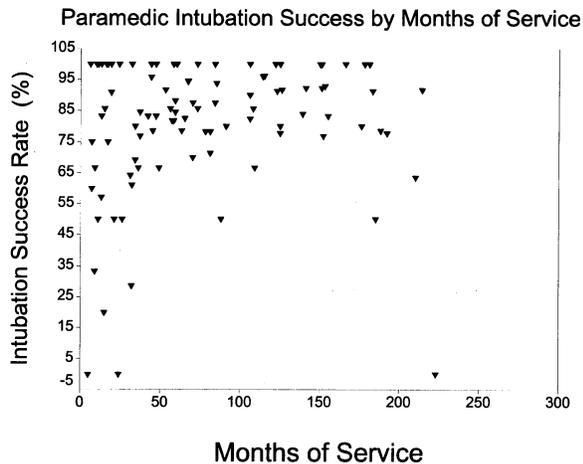


Figure 5. Correlation between months of experience per paramedic and intubation success.

may also lead to patient selection bias by the paramedic for the noncardiac arrest patient cohort. A paramedic treating a noncardiac arrest patient can choose not to attempt an intubation if the patient's airway is perceived to be difficult, even though the patient's condition may warrant endotracheal intubation for airway control. As a general rule, an intubation attempt should be made on every out-of-hospital cardiac arrest patient, thus assuring no selection bias by the paramedic.

Third, our study compares experience and intubation success using a split crew configuration (i.e., one paramedic/one EMT driver). The use of a dual paramedic crew can lead to another patient selection bias. A "more experienced" paramedic in a two-paramedic crew can selectively attempt intubations on presumed "more difficult" patients. In that scenario, the true intubation success rates for both crew members would be skewed (3). The split-crew configuration negates the potential selection bias because the paramedic is the sole ALS provider on the scene.

There are scarce data in the literature analyzing the relationship between paramedic experience and intubation success. In a 1992 study, the investigators found no significant difference in intubation success between "experienced" and "inexperienced" paramedic groups (13). Experience was defined as 20 or more intubations a year for over 2 years and the inexperienced group included everyone not in the experienced group and paramedic students on field internships. Because there were no descriptive statistics on either group, it is difficult to draw a conclusion about the effect of experience on intubation success. A paramedic may have had up to 19 intubations per year and still have been considered "inexperienced" by the investigators. The study also used number of intubations, not length of paramedic service,

to define experience. The investigators included noncardiac arrest patients and used two ALS provider crews (paramedic/paramedic or paramedic/nurse), both of which were potential sources of selection bias, as described previously.

A 1995 study also found no statistical difference between "experienced" and "inexperienced" groups of paramedics (12). Paramedic experience was calculated according to the paramedic's state license number because licensure numbers were given sequentially in the state where the study was conducted. This did not account for paramedics with previous experience in another state. The study did analyze the relationship between the number of patients in whom intubation was attempted per paramedic and success but found no statistical significance. The study included all intubations and used a two-paramedic crew, both potential confounding factors.

The results of our study resemble those of the Stewart group in Pittsburgh (2). In their study, they used months of experience as a paramedic in their system before intubation training, which theoretically should have no effect because all paramedics were trained in endotracheal intubation at the same time. Stewart found a significant correlation between the total number of patients in whom intubation was attempted with intubation success in his population of paramedics. Stewart used a similar patient population, which included cardiac arrest patients and patients who were deeply comatose. The Pittsburgh system utilized a two-paramedic crew, lending itself to potential selection bias.

Our study's hypothesis was that experience does have an effect on paramedic intubation success. A question that is routinely asked of EMS medical directors is how many intubations are needed by paramedics to stay proficient in that skill. This study was not designed to answer that question. However, understanding the correlation between skill retention and skill usage is applicable to maintaining system proficiency in endotracheal intubation. Health care systems routinely ask physicians for documentation on the number of procedures performed, including intubations, as proof of skill proficiency before granting privileges. The practice of maintaining skill proficiency is sporadic to nonexistent with out-of-hospital care providers. Ironically, this environment is where the patient may have the most to gain from emergent airway control.

If our results are confirmed in other systems, EMS directors may need to reconsider the optimal number of ALS providers needed for their systems. There are a limited number of patients requiring intubation per year in any given community. If the number of paramedics increases in the area, there will be a reciprocal decrease in the number of intubations per paramedic. From the

results of our study, it could be argued that having too many ALS providers in a system may actually be detrimental to maintaining sufficient skill levels if an active training program is not in place. Without adequate continuous airway training and quality assurance, the potential exists to create a spectrum containing a few paramedics who intubate frequently with resultant good success rates and many paramedics who intubate infrequently but with inadequate success rates (15). Kovacs et al. found that continuous training made a significant difference in intubation skill retention using a randomized controlled trial of educational interventions among non-EMS providers (16). Furthermore, Stewart et al. found no clear advantage of training paramedics to intubate in the operating room (OR), compared to manikin training, suggesting that the ability to maintain skill proficiency may not be very burdensome (2).

Equally as important is the necessity to track intubation proficiency within the EMS system. In an example of how patient care is compromised by lack of quality controls, Katz and Falk detailed a large percentage of unrecognized esophageal intubations in Orange County, Florida. The authors argued that the primary causes of this were nonexistent quality control, poor medical oversight, and lack of continuing education within multiple EMS services in the region (17). The esophageal intubation rate for our study was 0.66 per 100 patients (or one unrecognized esophageal intubation per 151 patients intubated).

LIMITATIONS

Orotracheal intubation was evaluated using the number of intubations performed per paramedic as a function of intubation success. Data on intubation frequency for the population of paramedics before the study period were not available. As a result, assessment of prior intubation experience as a possible confounder for this study was not performed.

There were also limited data on intubation training in the paramedic population before the study. Paramedics routinely were paid to attend all required continuing education unit (CEUs) courses to maintain licensure. The ambulance service provided CEUs for paramedics in-house and maintained a database of any CEUs taken by paramedics. Upon reviewing this database, we found that airway training received by paramedics was mostly didactic, and actual intubation skills training was done at Advanced Cardiac Life Support (ACLS) courses, which were required every 2 years. Training outside of the ambulance provider was negligible. Data on airway training or intubation experience before working at the ambulance service could not be obtained. During the

study period, there were no ongoing continuous quality insurance projects for airway management in the EMS system that could have confounded the intubation success rates.

The results of this study cannot be extrapolated to provide a basis for initial airway training or intubation maintenance programs. However, absent a program for maintaining intubation performance, a policy of having a certain number of intubations per year by some EMS systems may indeed be a valid argument to ensure skill maintenance (3,18,19).

CONCLUSIONS

In this study, there was a significant correlation between the number of patients in whom intubation was attempted and orotracheal intubation success for adult non-traumatic cardiac arrest patients. No significant correlation was found between months of experience and intubation success.

Future research should include a prospective design to account for paramedic education, intubation complications, and whether routinely scheduled intubation training alters the correlation between skill use frequency and intubation success.

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