



## Flexible nasotracheal intubation compared to blind nasotracheal intubation in the setting of simulated angioedema



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### ABSTRACT

**Background:** Nasotracheal intubation is rarely performed in the emergency department (ED) but may be required in specific situations such as angioedema. Both blind and flexible nasal intubation (FNI) may be utilized; however, the preferred technique is unknown.

**Methods:** We performed a randomized, crossover manikin study using a convenience sample of emergency physicians and medical students from a local community teaching hospital. Using a simulated angioedema model, we sought to compare the time required to successfully perform nasotracheal intubation between traditional blind nasotracheal intubation and FNI. Participants performed nasal intubation with both FNI using the Ambu aScope Slim (Ambu, Ballarup, Denmark) and blind nasal intubation with a Parker Endotrol tube (Parker, CO) in random order. Number of attempts and time to successful intubation (TTI) were compared between treatment devices. Providers were stratified by experience level, defining junior providers as post-graduate level 2 and below (including medical students) and all others as senior providers.

**Results:** We enrolled a convenience sample of 20 providers ranging from medical students to attendings. Overall, the TTI did not differ between blind and FNI intubation techniques (difference in seconds; 95% confidence interval) (21.4; −2.1 to 44.9;  $p = 0.07$ ). This was consistent across provider types: senior providers (26.6; −17.7 to 71;  $p = 0.24$ ) and junior providers (18.6; −8.3 to 46.5;  $p = 0.18$ ). Number of attempts was similar between techniques ( $p = 0.55$ ).

**Conclusion:** FNI and blind nasal intubation require similar time to intubation in this simulated model of angioedema.

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### 1. Introduction

Airway management is a critical skill in the acutely ill and injured patient. There have been several advancements in the field to increase the speed and safety of intubation including video assisted laryngoscopy and fiberoptic laryngoscopy. These have been shown to be a safe and effective alternative to direct laryngoscopy, especially in the setting of difficult airways [1,2]. Learning the safe application of these technologies is essential in the education of Emergency Medicine trainees [3,4]. It is important for practitioners to have experience with these devices both as primary

airway devices and as back up strategy when difficulties arise [1,2,5].

One unique difficult airway scenario involves angioedema, where traditional attempts at endotracheal intubation through the mouth may not be possible due to extensive swelling of the tongue and other structures of the oropharynx. In these situations, providers may be required to perform nasotracheal intubation by either blind nasotracheal intubation or fiberoptic nasal intubation (FNI) [2,5–8]. Nasotracheal intubation, in the Emergency Department (ED), is typically employed for awake, spontaneously breathing patients that require airway stabilization, as well as patients with suspected cervical spine injuries [6–9]. Blind nasotracheal intubation has risks including damage to turbinates, bleeding, and improper placement of the endotracheal tube [7,8]. In addition, providers may be reluctant to perform blind nasotracheal intubation as they are not able to visualize common airway

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structures key to successful completion of orotracheal intubation. FNI may help to reduce these complications and decrease the time required for intubation; however, FNI is infrequently utilized in the ED and provider comfort and experience with this procedure varies [9]. Clinical trials comparing these two techniques in the ED are lacking given the relative infrequent nature of nasal intubation (either FNI or blind). Using a simulated angioedema model, we sought to compare the time required to successfully perform nasotracheal intubation between traditional blind nasotracheal intubation and FNI.

## 2. Materials and methods

### 2.1. Study design

We performed a randomized, crossover manikin study using a convenience sample of emergency medicine attending physicians, emergency medicine residents, and 3rd and 4th year medical students from a local community teaching hospital. Participants performed timed nasotracheal intubation on a Sim Man 3G manikin (Laerdal, Stravanger, Norway) with simulated angioedema using each of two techniques in random order: Flexible (video) Nasal Intubation using the Ambu aScope Slim (Ambu, Ballarup, Denmark) and blind nasal intubation with a Parker Endotrol tube (Parker, CO). A 6-0 tracheal tube was used in each study arm. Device order was randomized according to a random number generator ([www.random.org](http://www.random.org)). Angioedema was simulated by inflating the tongue of the manikin as per the manufacturer's preset 'angioedema' function.

Participants were individually given a 10-minute, standardized presentation on how to use the Ambu aScope (FNI), the Endotrol and the significance of nasal intubation in the setting of angioedema. Subjects were then allowed up to 10 min to become familiar with the two nasal intubation devices without practicing on the manikin. All intubations were conducted in the same medical simulation lab on the same mannequin.

To time the blind nasal intubation approach, one investigator (SP) stood at the left side of the bed of the manikin and placed the FNI scope into the left nare and advanced the scope to point where the manikin's cords could be visualized by the study investigators. Another investigator (TE) stood at the head of the bed, so they could visualize the FNI screen and time the participants. To simulate the whistling sound of the Endotrol indicating that the tube location, the investigator at the head of the bed would play a prior recording of the Endotrol whistle (Beck Airway Airflow Monitor, Great Plains Ballistics, Lubbock, TX). Participants stood at the right side of the manikin and used the right nare for intubation in all cases. The whistling recording was started when the tube entered the nare. The whistling sound would stop if the tube was inserted into the simulated esophagus. The participant then placed a BVM onto the ET tube and delivered one breath. Correct placement was confirmed by the investigators with the FNI scope.

FNI intubation also was performed by participants on the manikin's right side utilizing the right nare. A standardized 6-0 tube was preloaded onto the FNI device. Participants utilized the scope to visualize the trachea and then passed the tube over the scope and beyond the cords. The FNI scope then was removed and the participant placed a BVM onto the ET tube and delivered one breath. Correct placement was confirmed by the investigator (TE) monitoring the procedure by viewing the tube pass the vocal cords.

### 2.2. Outcomes and covariates

Time to intubation (TTI) was defined as the time from when either the Endotrol or FNI was inserted into the nare and until

the participant attached a bag-valve-mask to the tube and delivered one breath. We also recorded the number of attempts for each device. An attempt was defined as each time either device (FNI or Endotrol) entered the nare. Each time the device was completely removed from the nare and reinserted was considered an additional attempt.

### 2.3. Subjects

Participants were emergency medicine residents, emergency medicine attendings and 3rd or 4th year medical students on their emergency medicine rotation recruited from a community teaching hospital with an affiliated 4-year emergency medicine residency. A convenience sample of subjects was enrolled after weekly didactic lectures to ensure maximum enrollment. Providers were stratified by experience level, defining junior providers as post-graduate level 2 and below (including medical students) and all others as senior providers. This study was approved by the local Institutional Review Board.

### 2.4. Data analysis

Descriptive statistics were used to report means with standard deviations and medians with interquartile ranges (IQR) when appropriate. Normality of the data was tested using the Shapiro-Wilk test. Time to intubate (TTI) was compared between devices. Based on prior work with airway placement in the simulated setting, we determined we would need a minimum of 18 subjects to be able to show a 6 second difference with 80% power and an alpha of 0.05 [10]. Absolute differences were calculated utilizing the *xtmixed* function with TTI as the dependent variable, technique as the independent variable and each participant as a random effect. We also created Kaplan-Meier curves comparing the TTI between FNI and blind intubation. All analyses were performed using Stata v 12 (Stata Corp. College Station, TX).

## 3. Results

Of the 20 participants, the median age was 28 with a slight male predominance 55% (11/20) (Table 1). The majority of participants were at a post-graduate year (PGY) training level of  $\leq 2$  (13/20) and a minority of participants were left-hand dominant providers (2/20) and only 2 of 38 (5%; both attendings) had prior experience with FNI in either the simulated or clinical setting. The median TTI (interquartile range) was 51.5 (36.4, 71.3) for FNI and 27.8 (20.5, 48.5) for blind. Overall, the TTI did not differ between blind and FNI intubation techniques (difference in seconds; 95% confidence interval) (21.4;  $-2.1$  to 44.9;  $p = 0.07$ ). This was consistent across

**Table 1**  
Participant demographics.

Demographic	Values
Age, median (IQR), years	28 (27, 31.5)
Male gender (%)	11 (55)
Right-handedness (%)	18 (90)
Previous experience with FNI (%)	2 (5)
Experience	
Medical student	3 (15)
PGY-1	6 (30)
PGY-2	4 (20)
PGY-3	3 (15)
PGY-4	1 (5)
Attending	3 (15)

PGY = post-graduate year.

IQR = intra-quartile range.

FNI = fiberoptic nasotracheal intubation.

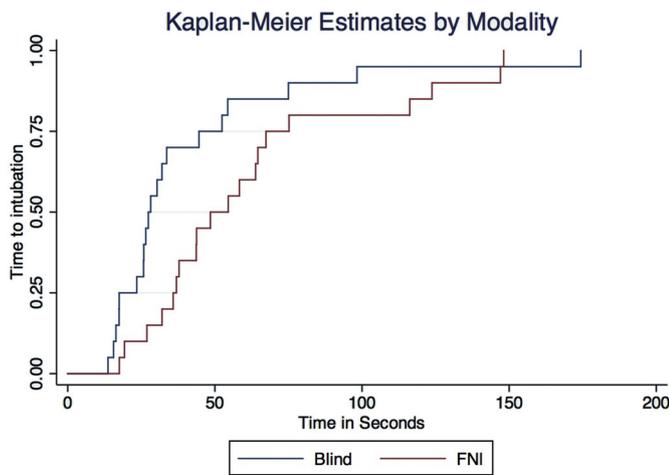
**Table 2**  
Intubation outcomes for providers

	FNI	Blind	Difference (95% CI)	p-Value
Median number of attempts (IQR)	1 (1, 1)	1 (1, 1)	n/a	0.55
All providers median time in s (IQR)	51.5 (36.4, 71.3)	27.8 (20.5, 48.5)	21.4 (−2.1 to 44.9)	0.07
Senior providers median time in s (IQR)	37.8 (19.3, 123.8)	30.4 (25.8, 75)	26.6 (−17.7 to 71)	0.24
Junior providers median time in s (IQR)	54.5 (43.7, 64.6)	27.4 (17.5, 44.6)	18.6 (−8.3 to 46.5)	0.18

FNI = fiberoptic nasotracheal intubation.

IQR = intra-quartile range.

s = seconds.



**Fig. 1.** Kaplan Meier estimates of time to successful intubation.

provider types: senior providers (26.6; −17.7 to 71;  $p = 0.24$ ) and junior providers (18.6; −8.3 to 46.5;  $p = 0.18$ ) (Table 2). Kaplan Meier curves were similar for both techniques (Fig. 1).

#### 4. Discussion

In our study of simulated angioedema, blind nasotracheal intubation resulted in similar intubation times compared to fiberoptic nasotracheal intubation. FNI is an important skill in Emergency Medicine, albeit seldom used. Current estimates suggest the rate of FNI to be used in roughly 1% of ED intubations with some academic centers reporting as few as 1 FNI annually [9]. As the availability of various scopes becomes more accessible, affordable and disposable, it is imperative that trainees become more familiar with its use as an adjunct to direct laryngoscopy. In cases where direct laryngoscopy may be unsuccessful or impractical (i.e. angioedema), nasotracheal intubation, specifically FNI may be considered.

Our study used a range of providers from medical students through attendings. The time to intubation for FNI was similar to the blind nasotracheal method overall, both in junior providers and senior providers. We segregated providers to evaluate for potential differences by experience as senior providers may have prior experience with nasotracheal intubation. Despite the potential for prior experience, all providers had similar results with both FNI and the blind approach. We believe this to be a function of the infrequent nature of nasotracheal intubation suggesting that either technique may be valid across a spectrum of providers. As such, providers may elect to choose the technique they feel most comfortable with.

Although we did not find a difference between techniques, FNI offers additional information that blind intubation does not such as the degree of airway edema, signs of trauma and the ability to identify other pathology that may explain the patient's symptoms (e.g. foreign body). As such, we believe there is still a role for FNI although how to best train providers in its use is unclear.

These findings could have several implications for clinical practice. Nasotracheal intubation may be the ideal option in specific patient populations. Our work suggests that providers were equally capable with both blind and FNI approaches with minimal training. A recent study from the NEAR database found that FNI has a first attempt success rate of roughly 50%, considerably lower than DL [9]. These rates are at academic centers and the rates may differ in other EDs. How to best train providers in FNI and assist them with skill maintenance is unknown however it is unlikely that clinical experience alone will be sufficient to maintain competency with this skill. Additional opportunities including cadaver labs and simulations training may be needed to gain and maintain experience with this skill.

#### 5. Limitations

This study has many limitations. First, we used a manikin with simulated angioedema. The inflated tongue may not have invoked a true setting of angioedema. Future trials will be needed to assess these techniques in the clinical setting. Subjects had limited training and time to familiarize themselves with the devices. The subjects may still have been learning how to use the device when performing the test, which could have artificially elevated the median times; however, given the infrequent nature of nasotracheal intubation, it is unlikely that most providers will be familiar with the technique and may need just-in-time training in either technique. Although we did not find a difference between techniques, our results border on significance with an absolute difference of 21.4 s (−2.1 to 44.9) longer for FNI compared to blind. Additional work may help to clarify this difference in the clinical setting as a 21 second difference, may be clinically significant. We only used one type of fiberoptic nasal scope as well as only one type of endotracheal tube. Further studies are needed investigating multiple types of FNI devices and blind techniques. We attempted to simulate the whistling that may be utilized when performing blind nasotracheal intubation and used the video monitor to determine tube position, stopping the whistling when the tube entered the esophagus. How this translates to the clinical setting will require further study. The assessors were not blinded to the study nor its results. Finally, we used a small convenience sample. A larger, randomized trial where assessors are blinded, would be needed to further validate these findings and may identify small differences in time intervals than our original power calculations accounted for.

#### 6. Conclusion

In our simulated setting of angioedema, TTI was similar between blind nasotracheal and FNI techniques.

#### Financial disclosure

SP, TE, EH and JNC have no financial conflicts of interest to disclose.

CAB is a member of the scientific advisory board for Verathon Inc. Verathon had no input into the study design, analysis, or decision to publish this work.

### Conflict of interest

The authors have no other conflicts of interest to disclose.

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