

Using a bedside ultrasound (US), an emerging technology, to confirm endotracheal tube (ETT) location in adults in emergency department

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ABSTRACT

Introduction: Airway management is the most important aspect of patient treatment in emergency medicine. Prompt confirmation of Endotracheal Tube (ETT) in larynx is imperative for avoiding complications in sick patient. With quick learning graph, Point of Care Ultrasound (POCUS) has high sensitivity and specificity for detection of ETT in place.

Method: A prospective observational study was conducted at adult Emergency Department of Tribhuvan University Teaching Hospital among patients undergoing intubation for various reasons. Transtracheal POCUS was used to confirm the tube placement. Time to confirm tube by POCUS in trachea and by bilateral chest auscultation was noted.

Result: Of the 71 intubations, 68 were correctly identified to be in trachea and 3 in esophagus, resulting in sensitivity and specificity of 100% each. Transtracheal POCUS was the fastest method to determine endotracheal intubation (8.08 ± 1.69 seconds) compared to bilateral chest auscultation (22.37 ± 3.45 seconds).

Conclusion: With high sensitivity and NPV for confirmation of correct endotracheal tube intubation and early detection, transtracheal POCUS in emergency could be a useful tool for prompt localization of ETT and instant action needed before final confirmation by other means.

Keywords: Auscultation, emergency medicine, endotracheal intubation, point of care ultrasound

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INTRODUCTION

Emergency department visit trend is increasing year by year.¹ Emergency Department of Tribhuvan University Teaching Hospital (TUTH) serves 45000 patients per year. On average 3-5 intubations are occurring per day in department of Emergency Medicine in TUTH. In emergency, airway management with endotracheal tube is a routine treatment with a high risk of complications. There had been around 12% complications related to intubation.² Rapid and accurate confirmation of endotracheal tube (ETT) placement in trachea is the important step in definitive airway management. There are few confirmatory techniques, with limitations, been proposed to identify ETT in trachea.³ Direct visualization of the tube passing through glottis is not always possible like that in difficult intubations, when there is profound oral secretions.⁴ Capnography is usually used to locate the ETT, although it has drawbacks, such as the possibility of false positives from hypopharyngeal placement and false negatives from cardiac arrest. There will be distention of stomach and potential for aspiration if ETT is in esophagus and positive pressure ventilation with capnography is used to confirm.⁵

Ultrasound machines are now increasingly available in emergency departments. Point of care ultrasound (POCUS) is noninvasive quick bedside tool to access superficial neck structures.⁶ Ultrasound has been shown to be a reliable method for identifying tracheal or esophageal location of ETT.⁷ POCUS is being investigated for the quick confirmation of proper ETT implantation while lowering the number of positive pressure ventilations as a result of the increased use of ultrasound in emergency rooms.⁸ Static, grayscale imaging are common methods to visualize the location of the ETT after placement.⁹ Most of the studies are done in cadavers which mimic the live scenarios.⁸ Studies that are done in live patients are conducted in controlled environment like pre-operative settings. However there are few studies that are conducted in emergency setting.¹⁰ This study aimed to access the usefulness of transtracheal POCUS in accurately identifying position of endotracheal tube in patients who are intubated at emergency of tertiary hospital of Nepal.

METHOD

A prospective observational study was conducted from September 2022 to November 2022 in intubated patients for various reasons (Glasgow

Coma Scale ≤ 8 due to head trauma, polytrauma, sepsis) at red area of adult emergency department. Ethical clearance was obtained from Institutional Review Committee of Institution {Ref:149(6-11) E2 079/080}. 3rd year DM Emergency resident experienced in performing bedside POCUS skills conducted the study. Taking sensitivity of transtracheal ultrasound to be 98.7%³ and using formula:

$$n = (Z^2 \cdot Sn \cdot (1-Sn)) / d^2$$

Where, n = Sample size, Z= 1.96 at 95% confidence level, Sn= sensitivity (0.987), d= margin of error (0.05).



Figure 1. Ultrasound view of tube in trachea

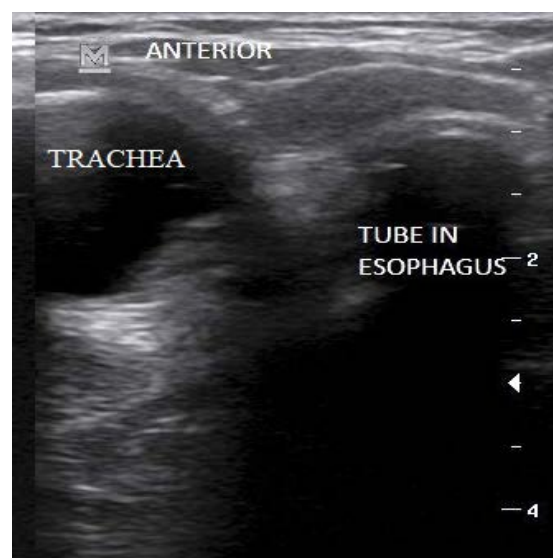


Figure 2. Ultrasound view of tube in esophagus

Sample size was 20. As per convenience sampling, 71 patients were enrolled. Severe neck trauma, abnormal anatomy of neck and patient's relative

not giving consent were excluded. Consent for study was taken from patient's family relative/visitor. Patient is intubated by emergency physician or emergency resident doctor performing duty at that time. Immediately after intubation, transtracheal POCUS with linear probe (Mindray M6) was kept above the suprasternal notch of patient to localize the ETT by researcher. Probe was manipulated on vertical and horizontal axis to localize the tube either in trachea or esophagus as shown in figure 1 and 2.

Once tube is localized time taken for localization is noted and picture saved. Then researcher auscultates bilateral chest for tube placement confirmation. Time taken for auscultation is noted. Senior consultant present at time of intubation verified tube position by the POCUS image and by auscultation along with maintenance of oxygen saturation. Demographic data was noted too. Data obtained were stored and evaluated by using IBM SPSS Statistics version 21.

RESULT

Total 71 intubations were performed, followed by transtracheal POCUS confirmation of placement. There were 68 (95.8%) tracheal intubations and 3 (4.2%) esophageal intubations.

Out of the 71 patients, most of the patients were from the age group of 40-62 (43.7%) with mean age of 49.6 years. The majority of patients were male (60.6%) as shown below in the figure 3.

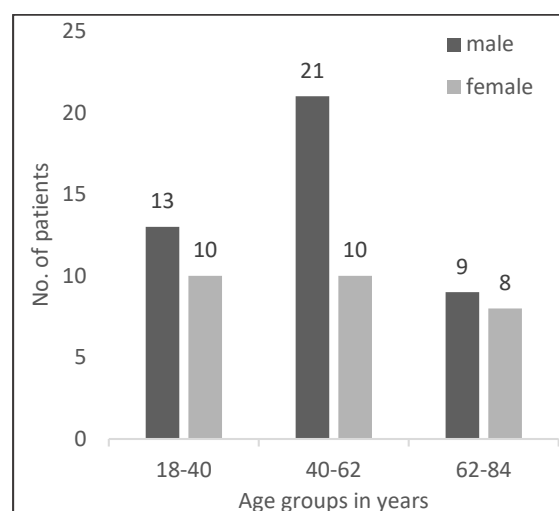


Figure 3. Age and gender-wise distribution of the patients

Table 1. Age wise distribution of intubated patients

Age (years)	Endotracheal intubation	Esophageal intubation	Statistics
18-40	22	1	Chi-square 0.193 P value: 0.908
40-62	30	1	
62-84	16	1	
Total	68	3	

Most of the endotracheal intubation were done in age group of 40-62 (44.1%) followed by age group 18-40 (32.3%) as shown in table 1. Three esophageal intubations had occurred among 71 patients. The p value here is 0.908 which is not significant.

Table 2. Gender wise distribution of intubated patients.

Gender	Endotracheal intubation	Esophageal intubation
Male	41	2
Female	27	1
Total	68	3

Of the 68 endotracheal intubated patients 41 (60.3%) were male as shown in table 2. Two male and 1 female patient had esophageal intubation. Those misplaced ET tubes were immediately removed and reintubated in trachea by emergency physician.

Confirmation of endotracheal tube placement in the trachea was done using transtracheal ultrasonography which showed 68 tracheal and 3 esophageal intubations as shown below in table 3.

Table 3. Summary of tracheal and esophageal intubation by tracheal ultrasonography N=71

	US tracheal	US esophageal
Tracheal intubation	68	0
Esophageal intubation	0	3

US, ultrasound

Since tracheal ultrasonography was able to detect and confirm all of the intubations done in the ED correctly, it yielded high sensitivity of 100% (Table 4).

Table 4. Test characteristics for tracheal intubation

	Total (n=71)
Sensitivity %	100
Specificity %	100
PPV %	100
NPV %	100

PPV, positive predictive value; NPV, negative predictive value

The mean time for transtracheal point of care ultrasound for confirmation of tube placement was 8.08 ± 1.69 seconds (mean $\pm$ SD) whereas

confirmation using bilateral chest auscultation was 22.37 ± 3.45 seconds (mean $\pm$ SD).

Out of 68 endotracheally intubated patients, 45 (66.2%) had equal air entry over lungs by auscultation. On the other hand, 14 (20.6%) patients had decreased air entry on left chest and 9 (13.2%) patients had decreased air entry on right chest during auscultation. Intubating doctor manipulated the ETT tube on finding decrease air entry on left side of chest. However, there was no manipulation of ETT tube on finding decrease air entry on right side of chest during auscultation.

DISCUSSION

Rapid and accurate confirmation of the ETT after intubation is utmost in Emergency Department. Thus, transtracheal POCUS being an emerging tool, it was used for rapid detection and confirmation of ETT after intubation in our study.

A prospective study was done to confirm endotracheal tube location using transtracheal POCUS among patients who were intubated at red area of Emergency Department of TUTH. In this study 71 patients were included. Out of 71 patients 68 had tracheal intubation and 3 had esophageal intubation. The sensitivity and specificity to detect the tube placement by using transtracheal POCUS was 100% each as transtracheal POCUS correctly identified all the tracheal and esophageal intubated tubes. This was in accordance with the study done by Abbasi et al.¹¹ and Chou et al.¹² Transtracheal POCUS is operator dependent skill to obtain and analyze appropriate images. Thus, its sensitivity and specificity vary based on operator experience and level of training. As there are studies with lesser sensitivity and specificity than our study as shown by Long et al.⁹ and Gottlieb et al.³

In this study adult patients were involved whose mean age was 49.6 years similar to that of study done by Abbasi, et al.¹¹ (48.96) but lower than Chou et al.¹² (71) The reason for this age difference could be selection of patients, as Chou et al. did transtracheal POCUS for endotracheal tube confirmation in patients undergoing CPR.

Majority of patients in our study were male (60.6%) similar to the study done by Chou et al.¹² but was in contrast to study done by Chowdhury et al.¹³ The reason for this sex difference could be doctor from anesthesia department conducting study in elective patients undergoing surgery.

The age group with majority of endotracheal intubation was 40-62 (41.4%). The reason behind this could be place as we conducted this study in adult emergency department. The P value of age group and transtracheal POCUS for ETT position detection was 0.908 which signifies age group and transtracheal POCUS for ETT position detection are independent.

The mean time for transtracheal POCUS for confirmation of tube placement was 8.08 seconds which is close to study conducted by M. Gottlieb et al.⁸ In a study by Chou HC et al.¹⁴ author got mean time 14.8 seconds for identification of endotracheal tube by transtracheal POCUS. The reason for decrease time of identification of endotracheal tube by transtracheal POCUS in our study could be DM resident doctor performing the study.

The mean time for confirmation of endotracheal tube by auscultation in the present study was 22.37 ± 3.45 seconds (mean $\pm$ SD) which is more than transtracheal ultrasound. Transtracheal POCUS is faster in detecting endotracheal tube position than bilateral chest auscultation which is also supported by the study performed by Chowdhury et al.¹³

Forty-five patients (66.2%) had bilateral equal air entry on auscultation, 14 (20.6%) had decrease air entry on left side of chest and 9 (13.2%) had decrease air entry on right side of chest during auscultation respectively. This decrease in air entry in left side of chest during auscultation could be attributed to ETT tube more towards right side, underlying left lung pathology. Similarly decrease air entry on right lung during auscultation could be attributed to underlying right lung pathology, ETT tube more towards left lung.

Our present study had some limitations. We did not use fibro-optic bronchoscope or capnography for confirmation of placement of tube after intubation. Since all the scans and auscultations were performed by single person, there could have been bias within results.

CONCLUSION

With high sensitivity and NPV for confirmation of correct endotracheal tube intubation and early detection, transtracheal POCUS in emergency could be a useful tool for prompt localization of ETT and instant action needed before final confirmation by other means.

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Conflict of Interest

None

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