First-attempt success and associated factors among emergency tracheal intubations in two government hospitals of Addis Ababa, Ethiopia.

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DECLARATION

The goal of this study is to assess the magnitude of first-pass success rate, factors associated with it and complications of emergency tracheal intubation in two government hospitals of Addis Ababa, Ethiopia. The signatory below affirms that this project is prepared by the author of this thesis. The thesis project is entirely original with no presentation at other places before. All the references of the materials used are properly sited.

Principal investigator

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Examiner

Name……...…. ……...Signature……...Date…….

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ACRONYMS

AaBET: Addis Ababa Burn Emergency Trauma

AAU: Addis Ababa University

CHS: College of Health Science

CI: Confidence interval

EMCC: Emergency and critical care medicine

ED: Emergency Department

EP: Emergency Physician

ETT: Endotracheal tube

HFNC: High flow nasal cannula

ICU: Intensive Care Unit

IHD: Ischemic Heart Disease

LMA: Laryngeal Mask Airway

NIV: Noninvasive ventilation

OR: Operation Room

OR: Odds Ratio

QI: Quality Improvement

RCT: Randomized Control Trials

RSI: Rapid Sequence Intubation

SBP: Systolic Blood Pressure

SGD: Supra Glottic Device

TASH: Tikur Anbessa Specialized Hospital

TBI: Traumatic Brain Injury

ZMH: Zewditu Memorial Hospital

ABSTRACT

Background: First-pass success in endotracheal intubations is essential as it affects further potential complications and patient outcomes. Though there are many studies done on the topic outside our country information about the topic in our country is scarce.

Objectives: The primary aim of this study was to know the first-pass success rate of intubations in two government hospitals in Addis Ababa, Ethiopia. Identifying factors associated with first-pass success and complications of tracheal intubation were also other aims of this study.

Methods: a cross-sectional study was done on a total of 112 patients who underwent tracheal intubation at Tikur Anbessa Specialized Hospital (TASH) and Zewditu Memorial Hospital (ZMH). Data was collected from patients who underwent tracheal intubation in the settings from May 2024 to October 2024. Physicians who performed tracheal intubation filled Google form questionnaire immediately post-intubation. The relationship between dependent and independent variables was tested using binary logistic regression. Multiple regression was done for variables that had a p-value of less than 0.25 on bivariate analysis. P value < 0.05 was taken as significant on multivariate analysis.

Result: A total of 112 intubations were included in the study. Most of these patients were male (62.5%) and young with a median age of 37.5 years (IQR 25-55). The commonest indication for intubation was hypoxic respiratory failure (68.8%). Most of the patients were intubated using the Rapid sequence intubation (RSI) technique (59.8%). Ketamine was the most common induction agent used for intubation (44.6%). The first-pass success rate of the intubations was 64.3%. Operators' experience, anticipated difficulty, Cormack Lehane grade, and vocal cord position on laryngoscopy were significantly associated with first pass success rate. One or more complications occurred in 37.5% of the patients. The commonest complication was cardiovascular instability (22.3% followed by esophageal intubation (18.8%) and hypoxemia (2.7%).

Conclusion and recommendation: First-pass success rate of emergency tracheal intubations was lower than the success rate from other studies but it was satisfactory. For the future, we recommend more work to improve the success rate and peri-intubation complication rate.

1. INTRODUCTION

1.1 BACKGROUND

The first thing to do in emergency medical care is to assess and manage the airway. Considering this endotracheal intubation is a definitive airway management strategy for patients who are indicated to. In the United States of America (USA), tracheal intubation in critically ill is the third most commonly performed procedure. The procedure is not a risk-free one and carries a significant risk of adverse events to the patients. As a result, Emergency airway management is a skill that should be mastered by every emergency physician (1, 2). Tracheal intubation is considered as difficult if it takes more than 2 attempts or more than 10 minutes to place the endotracheal tube (ETT) inside the trachea (3).

The history of tracheal intubation traces back to 460 BC when Hippocrates introduced tracheal intubation into the field of medicine for supporting ventilation in Greece. The modern era of tracheal intubation has passed through many stages from the early blind techniques using indirect laryngoscope in the early 19^{th} century to recent advancements in using low-volume, high-pressure ETT cuffs for intubation. More recent advancement in the area also includes using laryngeal mask airway (LMA) BlockbusterO, a supraglottic airway (SGA) to aid flexible bronchoscopy to perform tracheal intubations for managing difficult airway (4, 5).

Though there are variations in practice on who is performing emergency tracheal intubations in the emergency department (ED), most emergency intubations in the USA and Australia are performed by emergency physicians (EPs), emergency medicine residents, and attending physicians. In contrast, the practice in the United Kingdom (UK) is somehow different, as most intubations in ED have usually been performed by anesthetists. But with the recent evolvement of emergency medicine departments in the UK too, it was reached to the consensus for emergency physicians to have all the skills required to do tracheal intubations in the first 30 minutes after admission. (6) African studies also show some variations in this area. In a study done in Nigeria in 2014, 73. 9% of ED intubations were performed by anesthetists. In South Africa, in contrast, emergency medical care practitioners can practice pre-hospital emergency

tracheal intubations. Regardless of the variation in the specialty performing the procedure, the RSI technique, intubation using anesthetics, and neuromuscular blocking agents are the choice of intubation technique for emergency tracheal intubations (7, 8).

Tracheal intubations in the emergency are different from intubations in the elective operation room (OR) in so many ways. OR intubations happen under a controlled environment while in ED intubations, the clinical profile of the patients, urgency of the procedure, unfamiliarity of the physician to the patients, presence of full stomach, and underlying hemodynamic and respiratory compromisation put these groups of patients at risk of adverse events (9).

The incidence of difficult airway in OR intubation ranges from 1.15- 3.8% while in ED intubations, the incidence goes higher to 3.0- 5.3% (6). Another study supporting this states that intensive care unit (ICU) intubations are associated with worse glottic visualization than OR intubations (10). Tracheal intubation in critically ill patients carries a complication rate of up to 40 % in some series. These complications include risk of aspiration and desaturation, hypotension and shock, difficult laryngoscopy, and even cardiac arrest (2).

Many researches have shown that successful intubation on the first attempt is associated with lower rates of peri-intubation complications. As a result, first-pass success in intubations is labeled as one of the quality indicators of emergency care and has become a common outcome in emergency airway research (11, 12, 13). A large multi-center study done in Japan on patients undergoing tracheal intubation stated that there is an independent association between multiple attempts of tracheal intubation and adverse events. That's why we must aim for first-attempt success in emergent tracheal intubations (14).

For several years, successful first-attempt intubation used to be defined in several ways, but recent studies reached an agreement where the definition should be "placement of ETT into the trachea on 1 laryngoscope and 1 ETT insertion" (11).

1.2. STATEMENT OF THE PROBLEM

Tracheal intubation being one of the most commonly performed procedures in intensive care units is also associated with life-threatening complications in almost half of the cases (15). Some evidence shows that the incidence of complications that occur during peri-intubation can range from 30- 60% and these tracheal intubation-related complications include hypoxia, cardiovascular collapse, esophageal intubation, cardiac arrest, and even death. The occurrence of these complications makes the overall outcome of the patients poor (16, 17, 18).

Different approaches and strategies are in practice to avoid these complications and adverse events. These approaches include adequate pre-oxygenation, using appropriate devices, optimizing the hemodynamics, following airway management algorithms, apneic oxygenation, and meticulousness about the choice of drugs and timing of intubation (15). In this regard, evidence shows that performing tracheal intubation in a short time and successfully intubating the patient on the first attempt is associated with lesser peri-intubation complications. Many studies reported that multiple attempts were associated with increased intubation-related complications. That's why first-pass success is quality merit in emergency care (11, 12, 14).

The incidence of tracheal intubation first-pass success differs from one place to another. Studies have shown that first attempt success of tracheal intubation can range from 60- 80% (16, 17, 18). Other studies have shown a number greater than 80 in the success of tracheal intubation (19, 20, 21). However, a cutoff point of 85 % is taken as a standard and a quality goal to achieve in most emergency departments.

Because of the reasons mentioned above, first-pass success and ways to improve first-pass have become the area focus of many researchers worldwide (11, 12).

There are many risk factors identified so far about first-pass success. These risk factors include operator-related factors like clinical experience and working department, patient-related factors like the underlying condition of the patient, presence of anatomic difficulties, the type of laryngoscopy used, and usage of some devices to facilitate the success (18, 22, 23).

Hence, it is currently reached to the agreement of tracheal intubation and first-pass success should be a skill not only an anesthesiologist but also an emergency physician has to master (6). Some scientific evidence emphasizes the importance of fist-pass success in emergency intubations and subsequently safety outcomes (24).

Evidence shows that implementing airway training programs for the providers helped improve first-pass success and overall tracheal intubation outcomes. In one piece of evidence, it was shown that using emergency intubation procedure notes and guidelines and emphasizing on workshops to educate the staff improved the first-pass success rate from 57.1% to 80.0% (25, 26). Another evidence also supported this by stating endotracheal intubation outcomes, including increment in first pass rate, decrement in number of attempts, and lower rates of overall complications were improved, with the implementation of the ED multi-disciplinary quality improvement (QI) program (27).

In this regard, there were many quality improvement programs implemented in different parts of the world to improve the first-pass success of tracheal intubation. QI projects implemented in the USA, Canada, South Korea, and Saudi Arabia to improve tracheal intubation and their positive results, can be mentioned for instance (26, 27, 28 29).

Though there were some works done in this area in the continent, Africa, more studies and QI projects are still needed as data is scarce in the area as compared to the developed countries' statistics (30, 31). The existing evidence in our country is also not satisfactory. There were few studies done about the success of tracheal intubation in emergency departments in the country. The first of these studies was done at a single trauma center and measured the first-pass success but did not study factors associated with the success. The second study again just measured the overall success of tracheal intubation and did not address issues like first-pass success and outcomes of the intubations (32, 33).

Making a conclusion based on the above results about our county might be difficult as patient-related profiles seen in these hospitals are not uniform with the other hospitals. There were no studies about Tikur Anbessa Specialized Hospitals (TASH) and Zewditu Memorial Hospital (ZMH) profile in the area and that was one of the reasons behind the motive for this research.

The other reason was knowing about the factors associated with first-pass success and complications of emergency tracheal intubation in these settings.

1. 3 SIGNIFICANCE OF THE STUDY

This study played a paramount importance in giving information about the current success rate of first pass in tracheal intubations at TASH and ZMH. It also helped us identify factors affecting the success of first-pass on tracheal intubation in our setting. We also got an insight into complications related to tracheal intubation in our setting.

This study is believed to help guide future improvement of tracheal intubation practice in the department. Using this information this study will also be a base for further large-scale research and implementation of quality improvement projects. Further, the result will be communicated to the respective stakeholders, including the Federal Ministry of Health, for guidance in the preparation of local and national guidelines on the topic.

2. LITERATURE REVIEW

Different researchers operationally defined first-pass success in one of the two different mechanisms. The first group used the definition "successful placement of ETT on single laryngoscope insertion regardless of the ETT insertion attempts" (12, 19, 34, 35) while others in contrast used the definition of successful intubation following a single insertion of a laryngoscope followed by a single insertion of ETT (23, 36). Following this, Trent et al. conducted a secondary analysis of 2 RCTs and compared the success of the first attempt, the median difference in duration of intubation, and the development of complications by definition. From this, the study conductors concluded that using the definition, successful intubation using 1 laryngoscope insertion followed by 1 ETT insertion is better than the definition which uses 1 laryngoscope insertion with multiple ETT insertion as first pass success. The first definition was found to decrease the median duration of intubation by 35 seconds (11).

The success rate of first-attempt tracheal intubations varies from one to another setting. In an observational study in a single medical ICU by Amarlic et al, in France, the first-pass success rate of tracheal intubations was 62 % (37). In some other studies also the first-pass success rate on tracheal intubations ranged from 72.9%- 79.7% (9, 38, 39). A quality improvement project done on academic emergency departments in Saudi Arabia, done from 2018 to 2020 revealed first-pass success of 57.1% at the beginning of the QI project and later became 80% at the end (26).

In contrast to this a success rate greater than 80% was recorded in studies done by Mohr et al and Walls et al (86%) and (95%) respectively (20, 21). A systematic review and meta-analysis which included 21162 articles and 42,081 intubations in 10 countries which was first published on October 2016, stated that first pass success was 84.1% (19).

Studies done during the era of COVID also revealed first-pass intubation success of more than 80%. The first study was a multicentre prospective cohort study across 20 US academic Emergency departments. In this study, Mohr et al. mentioned that the first attempt success was 86% (20). Another prospective observational study done in Brazil by de Alencar JCG and his colleagues mentioned that the first attempt intubation success was 82% (40).

The reality in African countries is also more or less the same. In South Africa, information was collected from a database about paramedic students who performed intubations for 5 years from 2011 to 2015 which revealed a first-attempt success rate of 87.9% (8). In a one-year prospective observational study in a teaching university hospital in Nigeria, Legos, the success rate of first-pass intubations was 81.9% (7). In another prospective observational study on consecutive patients presenting to a teaching hospital in Ruanda, Kigali between January 1 and December 31, 2017, and who underwent tracheal intubation, 85.4% of patients were successfully intubated on the first attempt (42).

In Ethiopia, there was a single institution-based retrospective study done at Addis Ababa Burn Emergency Trauma Hospital (AaBET). The study was an intubation documentation sheet review of intubated patients from November 2017 to November 2018 and it revealed first-pass

success of 70.3%. This study is one of the few studies conducted in our country but didn't assess the factors associated with tracheal intubation success. The other limitation of the study was, the data collection method being documentation sheet review, retrospectively interfering with data completeness for analysis (32). A descriptive observational study was done at the University of Gondar Comprehensive Specialized Hospital (UOGCSH) from September 1st, 2018 to February 29 2019 on patients who sustained traumatic brain injury (TBI) and later required tracheal intubation. This study revealed all 75 patients who underwent tracheal intubation at recovery and ED were successfully intubated using direct laryngoscopy. Some standards like hemodynamic optimization and vomiting prophylaxis were not met for all the patients. This study also did not mention the first-pass success rate and complications associated with tracheal intubation (33).

Regarding factors affecting the success of tracheal intubation, there were studies done listing the possible factors. A systematic review done on 22 randomized control trials done 20 years before 2017, revealed that the use of pre-oxygenation with noninvasive ventilation (NIV) or high flow nasal cannula (HFNC) showed some possible benefits for getting better preprocedural oxygen saturation. While post-intubation recruitment showed improvement in oxygen saturation, the ramped position was associated with increased intubation attempts. The studies showed the absence of the effect of checklist and apneic oxygenation on oxygenation and hemodynamics, video laryngoscopy on the number of attempts, and sedative and neuromuscular blockers on hemodynamics.

Another independent factor shown in multiple studies to have a significant association with FPS was the operator's experience and specialty. A study done by Amalric and his collogues showed that there is an increase in the success of the first-pass during intubation as the operator's level of experience in the field increases. Coma among indications for intubation and a Mallampati score of 4 were associated with first-pass attempt failure (37). Many other similar studies done previously supported this result and stated operators' experience was independently associated with FPS (22, 49, 50)

A QI project done by Bakish and his colleagues from 2018- 2020 in Saudi Arabia mentioned good Cormack-Lehane grades being associated with increased first-pass success during intubation (26). The other risk factor associated with improved first-pass success and decreased intubation related complications, as described in multiple RCTs is the usage of a

bougie or stylet as compared to endotracheal tube alone (23, 44). Among the studies done in Africa, one prospective consecutive case series done in 40 trauma and burn patients from May 11 to July 17, 2016, it was mentioned that Pre procedural checklist use is associated with higher rates of first-pass success with $p<0.001$ (45).

Regarding complications related to tracheal intubation, the INTUBE trial which studied the intubation practice and adverse events among intubations in 29 countries stated that the occurrence of cardiovascular collapse was 43.4% (1199 out of 2760 patients). The most commonly encountered cardiovascular collapse was new initiation or increased infusion of vasopressors (87.7%), followed by systolic blood pressure (SBP) <90 for more than 30 minutes post-intubation and requirement of > 15 ml/kg fluid bolus to keep the blood pressure in the target range each counting for 24% and 13.2% of the cardiovascular collapses. Propofol was found to be an independent factor for cardiovascular collapse (OR 1.23;95% CI, 1.02- 1.49). (39).

In another RCT to study the effect of fluid bolus on cardiovascular collapse in patients undergoing intubation (PREPARE II) in 11intensive care units (ICUs) across the US from 2019 to 2021, Derek W et al. also mentioned that fluid bolus administration did not significantly decrease the incidence of cardiovascular collapse (36). In a systematic review and meta-analysis of first-pass success in emergency intubations, it was mentioned that the incidence of commonly encountered peri-intubation complications was hypoxia (6.4% (95% CI 2.5–11.9)), esophageal intubation (3.5% (95% CI 2.3–4.9)), hypotension (3.0%(95% CI 1.5–4.9)), cardiac arrest (0.6%(95% CI 0.2–1.0)) (19).

In many studies, it was shown that there is a significant association between the number of attempts on tracheal intubation and adverse events and complications (9), (14), (26), (40), (46). In a QI project done in Arizona, USA from 2007-2011, Sakles and his colleagues mentioned there exists a direct relationship between the number of attempts of tracheal intubation and adverse events. Adverse events occurred in 14.2 % of the first-pass success group and 53.1% of those who were intubated after multiple attempts. Oxygen desaturation which is one of the adverse events((ADs) occurred in 9.2% of the first-pass success group and 37.8% of the multiple-attempt group (9).

The complication rate in the study done in Ethiopia as mentioned by Zewdie et al was 28.5%. This study was done in a trauma center where 48% of patients were trauma patients (32).

Nevertheless, in TASH and ZMH most of the patients seen are medical so the figure might not be representative of the condition of our hospital. Plus, the limitations like the study technique (retrospective documentation review) put data completeness in doubt. In addition to this, risk factors and complications were not studied in depth and that's why there was an interest to do this research.

3. CONCEPTUAL FRAMEWORK

This conceptual framework shows the relationship between the independent and dependent variables using the following diagram. The risk factors were taken from research conducted on factors affecting first-pass success previously (26) (37) (45).

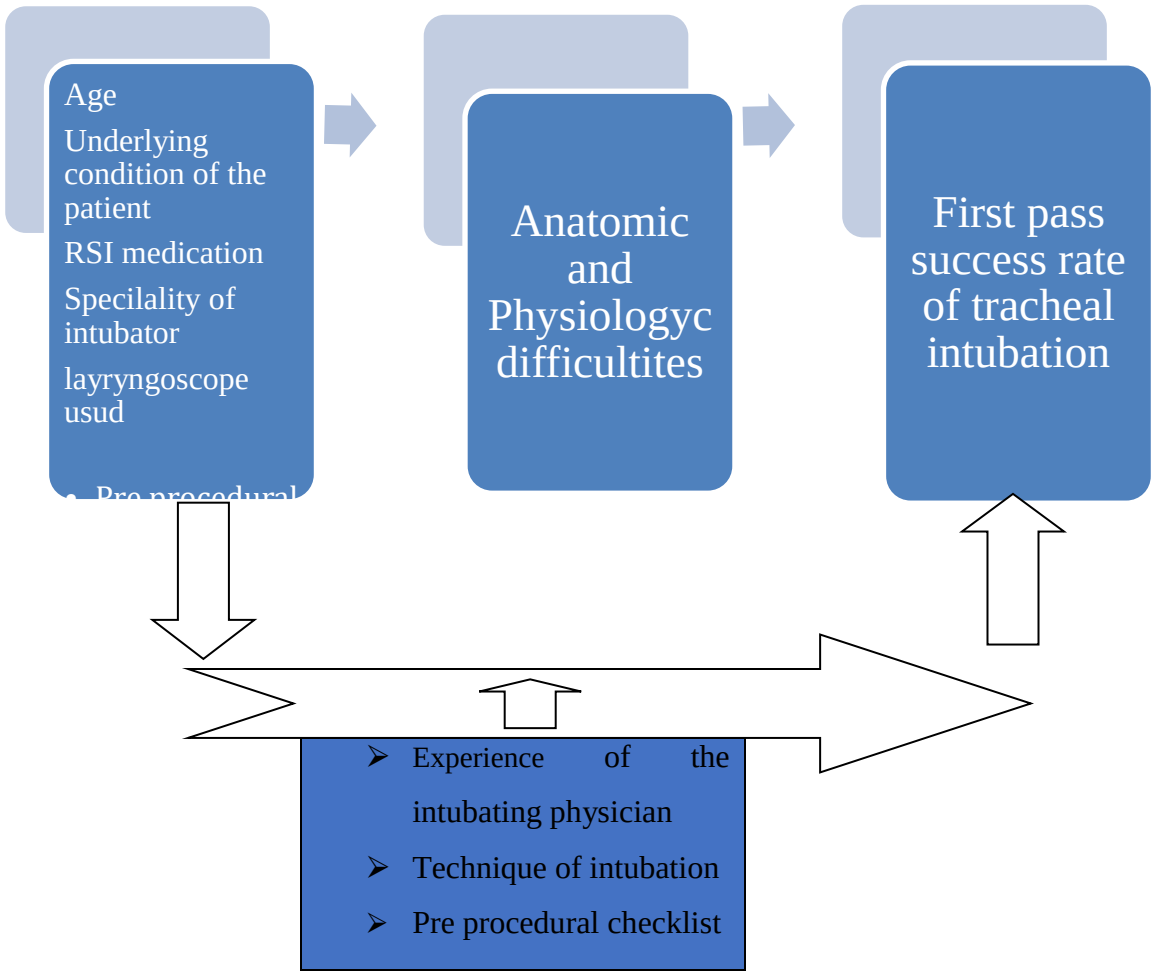

Figure 1- conceptual framework, the relationship between first pass success and tracheal intubation outcomes and factors affecting intubation success (26, 37, 45).

4 OBJECTIVES

4.1 GENERAL OBJECTIVE

- To assess the magnitude of first-pass success, factors associated with it and complications of emergency tracheal intubations in TASH and ZMH from May 2024 to October 2024

4.2 SPECIFIC OBJECTIVES

- To assess the magnitude of first-pass success of emergency tracheal intubations in TASH and ZMH from May 2024 to October 2024
- To identify factors associated with the first-pass success of emergency tracheal intubation in TASH and ZMH from May 2024 to October 2024
- To assess the complications of emergency tracheal intubations in TASH and ZMH from May 2024 to October 2024

5. METHODS

5.1 STUDY SETTING AND PERIOD

The study was conducted in two government hospitals in Addis Ababa, TASH and ZMH. Tikur Anbessa Specialized Hospital (TASH), since its establishment in 1950, is the largest referral and the main teaching hospital in Ethiopia. The hospital provides service for 370,000-400,000 patients per year. The hospital also serves as a teaching institution for undergraduate and postgraduate medical students, dentists, pharmacists, and other health professionals. In the emergency department of the hospital around 18,000 patients are being seen per year (47) (47) (49). The emergency department is comprised of 3 large rooms- red, waiting, and back. According to the monthly audit reports of the emergency, the red department has 7 beds and there currently are two mechanical ventilators and an average of 10 patients will be intubated per month.

Zewditu Memorial Hospital (ZMH), one of the university-affiliated hospitals in the center of Addis Ababa. It was initially opened in 1976 by the Seventh Day Adventist church, primarily aiming to give anti-retroviral therapy. Currently it is giving service for a significant number of populations in the city. In 2023, collaboration was started between Adiss Ababa University, the Department of Emergency Medicine, and ZMH to start an affiliation of EMCC residents and consultants. Since then, the intensive care unit of the hospital has mainly been run by the emergency medicine department.

ZMH ICU has 10 beds and 8 functional mechanical ventilators and on average there are around 10 tracheal intubations per month. In the emergency again though intubation is not a common practice some of the patients going to the ICU will be intubated in the emergency and some will be intubated before going out of the hospital for imaging or referral to other hospitals.

The emergency department at TASH has been giving a three-year emergency and critical care residency training program for over more than 10 years now. It is these residents and consultants, most of the time the senior year residents and consultants who perform the tracheal intubations at

these hospitals. The reason the hospitals were selected is because there was no study done on the topic in these areas previously and the clinical condition of patients is thought to be a representative of the patients in the city and the country at large.

The study period was 6 months from May 2024 to October 2024.

5.2 STUDY DESIGN

Cross-sectional study design

5.3 STUDY POPULATION

5.3.1 TARGET POPULATION

All patients undergoing emergency tracheal intubation at Addis Ababa

5.3.2 STUDY POPULATION

All patients who underwent emergency tracheal intubation at TASH ED and ZMH ED & ICU during the study period

5.3.3 STUDY UNIT

All patients who underwent emergency tracheal intubation at TASH emergency and ZMH emergency and ICU during the study period fulfilled the inclusion criteria.

5.4 ELIGIBILITY CRITERIA

5.4.1 INCLUSION CRITERIA

All emergency tracheal intubations undertaken at TASH emergency department and ZMH emergency and ICU during the study period

5.4.2 EXCLUSION CRITERIA

- ✓ Patients who came to the hospital after being intubated at other places
- ✓ Age less than 13

5.5 SAMPLE SIZE AND SAMPLING PROCEDURE

5.5.1 SAMPLE SIZE

The required sample size to achieve a 95% confidence interval and 3% margin of error using a proportion of 70.6% from a study done in Ethiopia, AaBET hospital (32) will be calculated as follows.

Using a single population proportion formula,

$$n = (za/2)^2 p(1-p)/ d^2,$$

where n=number of the study subjects

Z= the standardized normal distribution curve value for the 95% confidence interval (1.96)

P= 70.6 % from first pass success from a study done by AaBET hospital, Ethiopia (32).

d=the desired precision of the estimate (the margin of error between the sample and population, 3%)

$$n = 1.96^2 \text{ x } (0.706\text{x } (1-0.706))/0.03^2$$

n=886

Since our sampling frame, as taken from the monthly audit reports of the two hospitals, is 120 in 6 months, which is less than 10,000 we adjusted the sample size again

Nadj = n/ ((1 + (n/N))

Where, Nadj = desired sample size, when study population < 10,000

N=estimate of the population size

n= desired sample size when population >10,000

Nadj=885.975/ ((1+ 885.975/120))

106

By adding a 5% non-response rate, the final sample size will be

n/1-nr

n=112

The sample size calculated was crosschecked with the epi info application.

Table 1: Sample size determination assumption for the second objective

Factors	Power	Ratio	Proportion of exposures among controls	CI	OR	Proportions of exposure among cases	Case	Control	Total
Video laryngoscopy	80	1	34.3	95 %	2.43	56.3	88	88	176
Good Cormack-Lehane grade	80	1	31.4	95 %	2.71	55.4	75	75	150

The sample size calculated for our secondary objectives is higher than our sampling frame. Thus, the sample size obtained from the first objective was taken as the final sample size. Therefore, the final sample size taken was 112.

5.5.2 STUDY INSTRUMENTS AND PROCEDURE

Data was collected using a structured, -tested questionnaire which was filled by the intubating physician immediately post-intubation using a Google form. The tool for the data collection was adapted from the research done previously on the topic. Content validity was taken from experts and key informants on the topic. Pre-testing was done in 5% of the calculated sample size in the same study area and the questionnaire was modified based on the feedback from the pretest study. The hospitals where we conducted the study were selected using a convenient sampling method as our study period and budget we had were small. From the hospitals, we took the patients who underwent emergency tracheal intubation during the data collection period.

5.6 DATA COLLECTION AND PROCEDURE

The questions after getting adapted from other research on the topic and passing through content validity were first written on the Google form. The questionnaire was prepared in English language. Data was collected using structured and semi-structured questions which were filled in by the intubating physician post-intubation. The questions were close-ended and some open-ended questions which were organized into three sections. The first section is about the demographic parameters and baseline characteristics of the patients including comorbidities and active clinical condition of the patients. The operator's field of specialty year of residency, and the number of operators involved per intubation were also included in this part. The second section of the tool was about the peri-intubation events. This section included the indication for intubation, pre-intubation preparation, and difficulty assessment, sequence of intubation used, the medications, the type of laryngoscopy, the pre-intubation vital signs, and the anatomic position of the vocal cord on laryngoscopy visualization and Cormack Lehane grading. The third and the last section was about the outcome of the intubations. In this section, the number of attempts where the intubation was successful, the post-intubation vital signs, and post-intubation complications were included. The data filled by the physicians was cross-checked with the reports of the nurses on a morning meeting to decrease self-report bias. The patient's medical record number was filled on the form by the physicians before proceeding to the questions. Informed consent, in written form, was taken from each physician and data was not collected if the physician was not cooperative to give consent. The study participants were not required to reveal their identity and their responses were kept confidential.

5.7 DATA QUALITY CONTROL

To control the quality of the data collection regular supervision was given to the physicians by the primary investigator on how to fill out the questionnaire. Residents were free to address any challenges they encountered during the process of data collection. Before the main work of data collection, pre-testing was done in 5% of the calculated sample size. The pretest aimed to evaluate the clarity, comprehensibility, and relevance of the research tool, and the questionnaire was modified accordingly based on the feedback from the pretest. For each sample entered into the Google form there was an individual coding system (patient's medical record number) to help us identify data duplication, if there is any.

5.8 DATA ANALYSIS

The data after collection was organized and analyzed by the principal investigator. Data was initially checked for completeness and any missing values. To decrease missing values most of the questions were in the required mode on the Google form except for those questions in which the structure of the preceding question does not need an answer from everybody. It then was coded in Excel and entered into SPSS version 26 for analysis. Computerized data cleaning was done using SPSS before the data analysis. Univariate analysis using frequencies for qualitative variables and using descriptive statistics for quantitative variables was done on SPSS first. The descriptive data for quantitative variables was described using median and interquartile range as their distribution was not normal. Categorical variables were described using frequency and percentage. Two categorical variables were analyzed using the chi-square test. And correlation test was done for the continuous independent and categorical dependent variables using the Mann-Whitney test. Then the cause-and-effect relationship between the dependent and independent variables was tested using binary logistic regression. A model fitness test using Hosmer-Lemeshow goodness was done before going to binary logistic regression. Multicollinearity and outlier test was also done priorly and there were no extreme outliers. On binary logistic regression, 11 variables (Operator experience and specialty, anticipated difficulty, first vs re-intubation, apneic oxygenation, induction agent, Bougie or stylet use, lifting force, Cormack Lehane grade, vocal cord position, and BURP maneuver application) were found to

have an association with FPS with a P value of less than 0.25. These variables were then entered all together into multiple regression to exclude any confounding factors. P-value>0.05 was considered significant and 4 independent variables were identified to have significant association with FPS of emergency tracheal intubations.

5.9 STUDY VARIABLES

5.9.1 DEPENDENT VARIABLES

- Primary outcome
    - First-pass success of emergency tracheal intubations
- Secondary outcome
    - Complications and adverse events of emergency tracheal intubations

5.9.2 INDEPENDENT VARIABLES

- ✓ Age
- ✓ Sex
- ✓ Body habitus
- ✓ The underlying condition of the patient
- ✓ Bougie or Stylet use
- ✓ Induction drugs
- ✓ Preoxygenation technique and apneic oxygenation
- ✓ Pre-RSI vital signs
- ✓ Sequence used for intubation
- ✓ Specialty and experience of the intubating physician
- ✓ Anticipated anatomic airway and physiologic difficulty
- ✓ Cormack Lehane grading and vocal cord position on laryngoscopy
- ✓ Pre procedural checklist

5.10 OPERATIONAL DEFINITION

- ✓ **First pass success of tracheal intubation**: successful placement of ETT into the trachea on 1 attempt of laryngoscopy insertion followed by 1 ETT insertion attempt (23) (36).
- ✓ **Re-intubation**: re-intubations, where the patient extubated himself or extubated by a physician and re-intubation is required as he/ she couldn't tolerate the extubation
- ✓ **First intubation**: The intubation procedure was done for the first time on the current admission to the ED
- ✓ **Post-intubation cardiovascular instability:** occurrence of one or more of the following; Systolic blood pressure less than 65 mmHg between induction and 2 minutes post-intubation and requirement of > 15 ml/kg fluid bolus to keep the blood pressure in the target range; new or increased receipt of vasopressors between induction and 2 minutes post-intubation**;** cardiac arrest between induction and 1-hour post-intubation or death of a patient undergoing tracheal intubation between indication and 1-hour post-intubation (36).
- ✓ **Post-intubation hypotension**: Systolic blood pressure less than 65 mmHg between induction and 2 minutes post-intubation and requirement of > 15 ml/kg fluid bolus to keep the blood pressure in the target range or New or increased receipt of vasopressors between induction and 2 minutes post-intubation (36).
- ✓ **Post-intubation cardiac arrest**: Cardiac arrest of a patient undergoing tracheal intubation between induction and 1-hour post-intubation (36).
- ✓ **Post-intubation death**: Death of a patient undergoing tracheal intubation between indication and 1-hour post-intubation (36).

6 ETHICAL CONSIDERATIONS

The study was conducted after ethical clearance was obtained from the ethical Institutional Review Board (IRB) of the TASH and ZMH. Ethical clearance from AACAHB (Addis Ababa City Administration Health Bureau) was also taken before the data collection process. Then, data was collected after entering the official letter of permission from the IRB to each concerned body in TASH and ZMH. The questionnaire included written consent from study participants. Every respondent was informed about the objective of the study. Operators' confidentiality was assured and the questionnaire didn’t contain any personal identifying information of the operators, thus

ensuring the secrecy of the participants. All the data collected will used for the purpose of the study only. Data collected from the study will be stored in a file and won't be revealed to a third party.

7 RESULT

Demographics and baseline characteristics of the patients

A total of 112 consecutive intubations, which were undertaken at the two hospitals during the study period were included in the study. Demographic and baseline characteristics of patients are described in Table 2. Most of the patients were male (62.5%), with the median age being 37.5 years (IQR 25-55). 56.2% of the patients had 1 or more comorbidities. The commonest comorbidity was hypertension accounting for 42.9%.

Active clinical conditions of the patients varied, with non-traumatic coma (25.9%) being the most prevalent, followed by sepsis or septic shock (19.6%) and acute respiratory distress syndrome (ARDS) (17%). The majority of patients (47.3%) received supplemental oxygen via a non-re-breather mask.

Table 2: patient demographics and baseline characteristics

Patient characteristics	Subclass	Frequency	percent
Age median (IQR)_Yr		37.5	(25-55)
Sex	Male	70	62.5
	Female	42	37.5
Body habitus	Lean	88	78.6
	Obese	24	21.4
Comorbidity (n=63)	Hypertension	27	42.9
	Diabetes	18	28.6

	Malignancy (hematologic or solid)	8	12.7
	Asthma/ COPD	10	15.8
	Others	28	44.3
	No comorbidity	49	43.8
Active clinical condition	Sepsis or septic shock	22	19.6
	Coma (non-traumatic)	29	25.9
	TBI	18	16.1
	ARDS	19	17
	Poisoning	4	3.6
	Acute abdomen	5	4.5
	GBS	3	2.7
	Others	12	10.8
Pre-intubation vital signs Median (IQR)	Systolic blood pressure (SBP)	110	(90- 130) 1
	Pulse rate (PR)	118	(103-129)
	Respiratory rate (RR)	40	(30-48)
	Oxygen saturation (SPO2)	86%	(76%-90%)
Received supplemental oxygen	Nasal prong	10	8.9
	Simple face mask	34	30.4
	Non-rebreather mask	53	47.3
	CPAP/ BiPAP	15	13.4

IOR=inter-quartile range; COPD= chronic obstructive pulmonary disease; SBP= systolic blood pressure; CPAP/ BiPAP=continuous positive airway pressure / bilevel positive airway pressure

The majority of intubations (42.9%) took place in the ZMH ICU, followed by TASH Emergency (29.5%) and ZMH Emergency (27.7%). Place, operators, and intubation characteristics are shown in Table 3. Most of the intubations (61.6%) were performed by a single physician. Year II EMCC residents performed the majority of intubations (46.4%), followed by Year III EMCC residents (42.9%). The most common indication for intubation was hypoxic respiratory failure (68.8%), followed by airway protection (27.7%). The majority of the patients accounting for (86.6%) were intubated for the first time in the current admission while the rest (13.4%) were re-intubated after a failed inadvertent self or physician extubation.

Table 3: Place, operators, and intubation characteristics

	Subclass	Frequency	Percent
Place of intubation	TASH Emergency	33	29.5
	ZMH Emergency	31	27.7
	ZMH ICU	48	42.9
Number of operators involved per each intubation	1 physician	69	61.6
	2 physicians	30	26.8
	3 physicians	13	11.6
Operator's specialty and experience	Year I EMCC	4	3.6
	Year II EMCC	52	46.4
	Year III EMCC	48	42.9

	EMCC Consultant	4	3.6
	Anesthesia	4	3.6
Indication of intubation	Airway protection	77	27.7
	Hypoxic respiratory failure	17	68.8
	Hypercapnic respiratory failure	31	15.2
	Potential to deteriorate	5	4.7
First vs re-intubation	First intubation	97	86.6
	Re- intubation	15	13.4

TASH=Tikur Anbessa Specialized Hospital; ZMH= Zewditu Memorial Hospital; EMCC= Emergency medicine and critical care

Table 4 below shows pre-intubation preparation and optimizations made for the patients. Among the intubation preparations, appropriate patient positioning was ensured in 81.9% of FPS (first-pass success) group and 70% of first-pass unsuccessful tracheal intubations. Difficult laryngoscopy was anticipated in 35.8% of the FPS group and 35.1% of the first-pass unsuccessful group. Physiologic difficulty was more common in FPS intubations than in first-pass unsuccessful ones (71.1% vs 64.9%). Hemodynamic optimization was done for 60.7% of patients. Most of these patients (91.1%) were patients with physiologic difficulty.

The most common sequence used was RSI, used in 51.4% of FPS and 75% of first pass unsuccessful group. Sedation-only intubation was more common in the FPS group than intubations that required multiple attempts (29.2% vs 17.5%). BMV was the primary preoxygenation technique, used in 72.2% of the FPS group and 75.2% of the first-pass unsuccessful group. Succinylcholine use was more common in first-pass unsuccessful intubations than first-pass successful ones (77.5% vs 50%). Ketamine was the commonest induction agent used in the intubations. The laryngoscopy used in all of the intubations was a direct laryngoscopy.

Table 4: pre-intubation preparation and hemodynamic optimization

	Subclass	First-pass successful No/ percent	First-pass unsuccessful No/ percent
Intubation preparation and planning (n=112) (Pre-procedural checklist)	Appropriate patient positioning	59/ 81.9%	28/ 70%
	Assessment of potential airway difficulty	45/ 62.5%	18/ 45%
	Verbalized "Plan A", "Plan B", "Plan C"	32/ 44.4%	17/ 42.5%
	Equipment and backup preparation	44/ 61.1%	25/ 62.5%
	Assigned individual roles for team members	53/ 73.6%	27/ 67.5%
	Post intubation sedation and analgesia preparation	46/ 63.9%	22/ 55%
Difficulty anticipation (n=90)	Difficult laryngoscopy	19/ 35.8%	13/ 35.1%
	Difficult BMV	11/ 20.8%	10/ 27%

	Difficult Extra glottic device	0/ 0.0%	3/ 8.1%
	Difficult cricothyroidotomy	0/ 0.0%	1/ 2.7%
	Physiologic difficulty	38/ 71.1%	24/ 64.9%
Hemodynamic optimization (n=68)	Isotonic saline 20 ml/kg	42/ 97.7%	23/ 92%
	Vasopressors	19/ 44.2%	9/ 36%
	Blood products	1/ 2.3%	1/ 4%
Sequence of intubation	Sedation only intubation	21/ 29.2%	7/ 17.5%
	RSI	37/ 51.4%	30/ 75%
	DSI	1/ 1.4%	0/ 0.0%
	Crush intubation	13/ 18.1%	3/ 7.5%
Pre-oxygenation technique	Non-rebreather mask	11/ 15.3%	5/ 12.5%
	BMV	52/ 72.2%	29/ 75.2%
	CPAP/ BiPAP	2/ 2.8%	2/ 5%
	HFNC	5/ 6.9%	3/ 7.5%
	None	2/ 2.8%	1/ 2.5%
Neuromuscular blocking agent	None	9/ 22.5%	34/ 47.2%
	Succinylcholine	31/ 77.5%	36/50%
	Rocuronium	0/ 0.0%	1/ 1.4%
	Vecuronium	0/ 0.0%	1/ 1.4%
Induction agent	No induction agent	3/7.5%	13/ 18.1%
	Ketamine	16/ 40%	34/ 47.2%
	Propofol	11/ 27.5%	15/ 20.8%
	Ketamine and propofol	10/ 25%	10/ 13.9%

Outcome and complications of tracheal intubations

Regarding the outcome of tracheal intubations, the majority of intubations were successful on the first attempt (64.3%) while 25% required a second, 8% a third and 2.7% required more than three attempts. Placement of tracheal intubation was confirmed with direct visualization technique in the majority of the patients (85.7%). The median and IQR for post-intubation SBP and PR were 100 mmHg (IQR 85-120) and 115 bpm (IQR 100-125.5) respectively. Overall, one or more complications occurred in 37.5% of the patients. The commonest among the complications is cardiovascular instability accounting for 22.3%. Cardiac arrest occurred in 5.35% and death in 2.6% of total intubated patients. 2.7% of patients experienced hypoxemia

during the intubation attempts. Other complications occurred in 6% of intubated patients. These complications were pneumothorax, aspiration, injury to the oropharynx and vocal cord, and failed airway. The study couldn't show a statistically significant association between FPS and complications (p=0.425). The outcome and complications of the emergency tracheal intubations are shown in table 5 below.

Table 5: Outcome of tracheal intubations

Outcome	Subclass	Frequency	Percent
Success of tracheal intubation	First attempt	72	64.3
	Second attempt	28	25
	Third Attempt	9	8
	More than 3 attempts	3	2.7
Post-intubation vital signs Median (IQR)	Fio2	100%	(100- 100)
	Oxygen saturation (SPO2)	96%	(93-98)
	Systolic blood pressure (SBP)	100	(85-120)
	Pulse rate (PR)	115	(100-125.5)
Overall complication rate		42	37.5%
Cardiovascular collapse	New or increased	11	44%

(Between induction and 1-hour post-intubation (n= 25)	vasopressor administration		
	SBP less than 65	10	40%
	Arrhythmia	1	4%
	Cardiac arrest	6	24%
	Death	3	12%
ET tube misplacement		21	18.8%
Hypoxemia (SPO2 </=80 during the attempts		3	2.7%
Other complications (n=7)	Aspiration	1	14.3
	Pneumothorax	2	28.6
	Injury to vocal cord	2	28.6
	Injury to oropharynx	1	14.3
	Failed airway	1	14.3
ETT placement confirmation technique	Direct visualization	96	85.7%
	Auscultation	93	83%
	Point of care ultrasound	12	10.7%
	Radiography	1	0.9%

Factors affecting first-pass success of tracheal intubation

Results of multivariate analysis for factors affecting first-pass success rate of tracheal intubation are shown in Table 6 and Table 7 below.

Operator experience was significantly associated with the first-pass success of tracheal intubations. Year II EMCC and Year III EMCC residents were more successful in intubating patients on the first-pass than first-year residents with aOR of 46.806 (95% CI 3.031-722.719) (p< 0.006) and aOR of 406.295 (95% CI 13.719-12033.007) (p value < 0.001) respectively. Those intubations without any anticipated anatomic or physiologic difficulty were 10.7 times more likely to be successful on the first attempt than those which had difficulty, with aOR=10.73 (95% CI 1.007-114.453) and p-value of 0.049.

The Cormack Lehane grade III is associated with less success of intubation on the first attempt than it being a grade I, aOR =0.005 (95% CI 0.000-0.828) (p= 0.042). The abducted position was 23.9 times more associated with first-pass success than adducted position, aOR= 23.961 (95% CI 2.933-195.755) (p=0.003). The intubation being a first or re-intubation, the use of apneic oxygenation during the intubation, and the use of an induction agent had significant association on bivariate analysis but didn't show significant association on multivariate analysis. Using a bougie or stylet to aid intubations was also not significantly associated with the first-pass success of tracheal intubation on multivariate analysis (p= 0.175 and p= 0.426 respectively for stylet and bougie in this study.

Table 6: Factors associated with first-pass success of tracheal intubation 1

Factor	Subclass	First pass success n/ (%)	First pass failure n/ (%)	cOR (95% CI)	aOR (95% CI)	P value
Operator's experience and specialty	Year I EMCC	3/ 4.2	11/ 27.5		1	
	Year II EMCC	39/ 54.2	23/ 57.5	6.217 (1.569-24.631)	46.806 (3.031-722.719)	0.006*
	Year III EMCC	29/ 40.3	5/ 12.5	21.267 (4.334-104.364)	406.295 (13.719-12033.007)	< 0.001*
	Anesthesia	1/ 1.4	1/ 2.5	3.667 (0.173-77.552)	104.709 (1.434-7644.366)	0.034*
difficulty	Yes	53/ 73.6	37/ 92.5		1	

anticipated						
	No	19/ 26.4	3/ 7.5	4.421 (1.220-16.030)	10.737 (1.007-114.453	0.049*
First vs re-intubation	Re-intubation	7/ 9.7	8/ 20		1	
	First time	65/ 90.3	32/ 80	2.321 (0.773-6.968)	0.373 (0.014-9.608)	0.552
Apneic oxygenation	No	53/ 73.6	23/ 57.5		1	
	Yes	19/ 26.4	17/ 42.5	0.485 (0.214-1.098)	0.619 (0.123-3.108)	0.560
Induction agent	No induction agent	13/ 18.1	3/ 7.5		1	
	Ketamine	34/ 47.2	16/ 40	0.490 (0.122-1.967)	3.394 (0.332-34.690)	0.303
	Propofol	15/ 20.8	11/ 27.5	0.315 (0.072-1.378)	2.643 (0.238-29.363)	0.429
	Ketofol	10/ 13.9	10/ 25	0.231 (0.050-1.067)	4.385 (0.234-82.248)	0.323

Table 7: factors associated with first pass success of tracheal intubation 2

Factor	Subclass	First pass success n/ (%)	First pass failure n/ (%)	COR (95% CI)	AOR (95% CI)	P value
Bougie vs stylet	None	33/ 45.8	13/ 32.5		1	
	Stylet	28/ 38.9	24/ 60	0.460 (0.198-1.067)	0.292 (0.049-1.729)	0.175
	Bougie	11/ 15.3	3/ 7.5	1.444 (0.346-6.029)	3.561 (0.156-81.052)	0.426
Lifting force	No	32/ 44.4	10/ 25		1	
	Yes	40/ 55.6	30/ 75	0.417 (0.177-0.978)	0.202 (0.030-1.345)	0.098

Cormack lehane grade	Grade I	29/ 40.3	2/ 5.0		1	
	Grade II	41/ 56.9	25/ 62.5	0.113 (0.025-0.515)	0.269 (0.038-1.928)	0.191
	Grade III	1/ 1.4	7/ 17.5	0.010 (0.001-0.125)	0.005 (0.000-0.828)	0.042*
	Grade IV	1/ 1.4	6/ 15	0.011 (0.001-0.148)	0.076 (0.001-6.095)	0.250
Vocal cord position	Adducted	13/ 18.1	29/ 72.5		1	
	Abducted	59/ 81.9	11/ 27.5	11.965 (4.779-29.957)	23.961 (2.933-195.755)	0.003*
BURP maneuver	Not applied	56/77.8	11/ 27.5		1	
	Applied	16/ 22.2	29/ 72.5	0.108 (0.046-0.264)	0.298 (0.052-1.727)	0.177

8 DISCUSSION

This study assessed the first-pass success rate of emergency tracheal intubations in the two hospitals (TASH and ZMH). Regarding baseline patient characteristics, most of our patients were young and male. The median age was 37.5 years (IQR 25-55) and males accounted for 62.5% of the patients.

Overall, the first-pass success rate of the tracheal intubations was 64.3%. In our study, various patient and operator-related factors were found independently associated with FPS. Among these factors are the operator's experience and anticipation of a difficult airway. Year II and Year III EMCC residents were more successful in intubating patients on the first pass than first-year residents with aOR of 46.806 (95% CI 3.031-722.719) ($p< 0.006$) and 406.295 (95% CI 13.719-

12033.007) ($p < 0.001$) respectively. Cormack Lehane grade and vocal cord position on laryngoscopy were also found to have a significant association with first-pass success in our study. One or more complications were evident in 37.5% of intubations in this study. Among the complications, cardiovascular collapse was the commonest accounting for 22.3%. The commonest cardiovascular complication was new or increased vasopressor requirement accounting for 44% followed by SBP </= 65 mmHg (40%), cardiac arrest (24%), and death (12%) of the CVS complications.

This study was at risk of some possible systematic biases. The data collection technique we used could put the results on recall and Self-report bias. This might have led to an overestimation of the success rate and an underestimation of complication rates. To decrease the effect of non-response bias, the non-response rate was calculated and added to the total sample size. Operator's privacy was maintained and their identity was kept confidential and this is believed to be helpful in decreasing attention bias.

The first-pass success rate in our study was 64.3%. Among studies done previously, some showed a first-pass success rate somewhat closer to this number. Amarlic et al. mentioned first-pass success rate in their study was 62% (37). A study done by Sakels and his colleagues also showed an FPS of 72.9% (9). In multiple QI projects again, it was shown that the first-pass success rate before the projects was low and improved after the projects (24, 26). In a QI project done in Saudi Arabia from 2018- 2020, Bakish et al mentioned FPS improved from 57.1 to 80% after the QI project (26).

In contrast to this, some other studies showed a higher first-pass success rate. The success rate in these studies was above 80% (7, 23, 22, 20, 34, 42). The possible reasons for this discrepancy could be the difference in the clinical condition of patients and the indication of intubation. The number of comatose patients in our setting was high (42%) which might have contributed to a decrease in the success rate (37). RSI which is recommended for ED intubations for its advantage in increasing first-pass success rate (8, 20, 42) was only used in 59.8% of intubated patients in our setting. 38.3 % of our intubations were also undertaken without the use of NMBA which could also have played a role in the lower number of success rates recorded, as NMBA use was stated to be associated with improved FPS in multiple studies previously (3, 48).

Most of our intubations (96.4% of them) were performed by trainees, emergency medicine or anesthesia residents. This might also have contributed for a relatively small number of success rate recorded in our setting. In studies done by Nauka et al FPS was 82.9% and by Nauka et al FPS was 86-87%, in which cases 92.6% and 100% of operators respectively were attending physicians and advanced care providers (20, 34). In this study, 100% of our intubations were performed using a direct laryngoscopy.

The definition of first pass we used "Successful laryngoscopy insertion on 1st attempt followed by single attempt of ETT insertion" was also shown by previous studies to be associated with a lower FPS rate as compared to the definition that uses " a single insertion of laryngoscope despite the ETT insertion attempts" (11). In studies done by Zewdie and his colleagues, FPS was 70.3% (32) and by de Alencar et al FPS was 82% (40) which is higher than our success rate and one of the reasons could be the definition they used for FPS being a single insertion of laryngoscope despite ETT insertion attempts.

Regarding factors affecting the success of first-pass, in our study operator's experience and anticipation of difficult airway were found to have a statistically significant association with FPS. Many other similar studies done previously supported this result and stated operator's experience was independently associated with FPS (22, 49, 50). In our study, those intubations without any anticipated difficulty were 10.7 times more likely to be successful on the attempt than those which had difficulty, aOR 10.737 (95% CI 1.007-114.453) (p = 0.049). A study done by Pacheco and his colleagues was coherent to this result (51). Cormack Lehane grade was also found to be independently associated with FPS in this study. Grade III Cormack Lehane is associated with less success of intubation on the first attempt than grade I, aOR =0.005 (95% CI 0.000-0.828) (p= 0.042). Incoherent to this, an emergency QI project by Bakish and his colleagues showed good Cormack–Lehane (grades 1–2) was independently associated with improved first-pass success OR =2.71 95% CI (1.74–4.20) (26).

Though in a study done previously, a systematic review and meta-analysis by Oliveira and his colleagues, showed apneic oxygenation was associated with an increased first-pass success rate (OR 1.59; 95% CI 1.04 to 2.44), our study couldn't show a significant association (52). Our study also failed to show a significant association between usage of bougie or stylet and FPS (p= 0.426 and p= 0.175) respectively.

Regarding complications associated with tracheal intubation, one or more complications were evident in 37.5% of intubations in this study. The rate of complication in a study done at AaBET hospital as stated by Zewdie and his colleagues was 28% which is less than the complication rate in our study (32). The reason for the discrepancy could be the difference in the clinical condition of the patients. In a multicenter prospective cohort study done in 29 countries, cardiovascular instability as stated by Russeto et al was 43%. This number as compared to the one we got is a bit higher likely because the commonest induction agent used in their case was propofol while in ours was ketamine. The other possible reason could also be the median age of patients in their case being 63 IQR (49-74) while in our case is 37.5 years (IQR 25-55) (12). A complication rate even higher than this was recorded in an observational study of emergency room (ER) endotracheal intubation in Lagos University Teaching Hospital. Though the first pass success rate in this study was good (81.9), 93.6% ended up having complications at intubation (7). In our study cardiac arrest occurred in 5.3% and death in 2.6% of the total intubated patients. Similar to this in a study done in South Africa, Johannesburg, cardiac arrest in their study happened in 5% of the cases (8).

Though it was shown in multiple studies that there is an association between number of attempts in tracheal intubation and peri-intubation complications (14, 38, 55, 46) our study failed to show statistically significant association between FPS and complications.

9 LIMITATION

This study has several limitations. The first limitation is the study was done over a short period with a small sample size making generalization difficult. Secondly, the data was collected from the intubator, him/herself feeling the questionnaire post-intubation, placing the study at risk of recall and self-report bias. This might have led to an overestimation of the success rate and an underestimation of complication rates. This study did also not address the outcomes of patients past the peri-intubation period. In-hospital mortality and length of stay were also not included in the study.

10 CONCLUSION

In our very first study regarding the FPS rate and factors associated with it at our setting, the success rate was found satisfactory. But the success rate was lower than the standard and the results of previous studies so work needs to be done to achieve a higher success rate in the future. This study also gave insight into the factors associated with FPS and the rate of complication. Among the risk factors, the operator's experience and absence of anticipated difficulty were associated with improved FPS. Cormack Lehane grade and vocal cord position on laryngoscopy were also found to be independently associated with FPS. Regarding peri-intubation complication rates, though there were studies with a higher rate than ours, ours is also not small enough and needs to be worked on.

11 RECOMMENDATION

We recommend future large-scale studies over a long period to help with generalization. This study was done in two centers which is among the strengths but since the operators were from the same institution we recommend future studies to include other multiple centers too. This study also failed to illicit factors associated with peri-intubation complications and this should be an area of focus in future studies. We also recommend further studies to be prospective observational studies to avoid recall and self-report bias.

Video laryngoscopy should also be available and its usage be a trend for ED intubations especially for those with difficulty. RSI and NMBA use as shown above was lower in our study and has impacted the success rate of tracheal intubation. So cautious use of RSI should be encouraged for future practice. It was shown in multiple studies that the implementation of QI

projects and their effect on improving the first-pass success of tracheal intubation. We recommend this practice to implemented in our setting.

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ANNEXES

Annex 1: Information Sheet and Consent form

Research Project: First-attempt intubation success and associated factors among patients in two government hospitals of Addis Ababa, Ethiopia, a cross-sectional study

Name of Principal Investigator: Dr Tsion Kindie

Introduction This information sheet and consent form is prepared by the investigator whose main aim is to study first-pass success, factors affecting it, and complications of emergency tracheal intubations in two government hospitals in Addis Ababa, Ethiopia. The investigator is a third-year EMCC resident at TASH.

Purpose: The purpose of the study is to know the magnitude of first-pass success at TASH and ZMH which we don't know so far. The study also aims to identify factors that affect the success of first pass in tracheal intubations and complications associated with it.

Procedures: I kindly invite you to take part in this research as I believe the information you will provide is going to be necessary and valuable. Participation in the study is voluntarily. If you are willing to participate in this project, I kindly ask you to understand and sign the consent form. The response you will give and the results obtained will be kept anonymous and confidential. No one outside the research team will have access to your responses.

Risk and/or Discomfort: There is no risk that this research will pose to its participants.

Benefits: This study will have paramount importance to generate a hypothesis for further research which will be done in the area. It will also be a base for further quality improvement projects in the area. Further, the result will be communicated to the respective stakeholders, including the Federal Ministry of Health, for reviewing national guidelines on the topic.

Incentives: There is no incentive associated with the study

Confidentiality and Anonymity: The information we will collect from this research project will be confidential. Information about you that will be collected from the survey will be stored in a file, which will not have your name on it, and it will not be revealed to anyone except the principal investigator.

Right to Refuse or Withdraw: you have the full right to refuse to participate in this research (you can choose not to respond to some or all of the questions). If you do not wish to participate, this will not affect you. You also have the full right to withdraw from this study without losing your rights as a site resident.

Persons to contact for further information: If you have any questions, you can contact the principal investigator at the following address:

Name: Dr. Tsion Kindie

Tel: +251931489348

Email: tsionnkiendie27h@gmail.com

If you agree to participate in this study, please put a sign below to show if you are willing to participate. Are you willing to participate in this study? Yes[] No[]

Annex 2 questionnaire

Section I: Demographic parameters of the patient and intubating physician's profile

1. Age _____
2. Sex _____
3. Estimated BMI_____
4. MRN_____
5. Body habitus of the patient

A, Lean Body

B, Obese

6. Which of the following chronic conditions or commodities does the patient have?

A. Hypertension

B. Diabetes

C. Malignancy

D. COPD

E. Asthma

F. Cardiac condition

G. CKD

H. Others

I. No known chronic condition

7. If your answer for question number 5 is others, can you please specify the condition?

_____

8. Current active diagnosis of the patient?
9. The place where the intubation was undertaken

A. TASH emergency

B. ZMH Emergency

C. ZMH ICU

10. How many physicians were involved in the tracheal intubation? Physicians who tried the intubation attempt only

A, 1 person

B, 2 person

C, 3 person

D, more than 3 person

11. The educational level of the person who tried the 1st attempt of tracheal intubation?

A, Year 1 EMCC resident

B, Year 2 EMCC resident

C, Year 3 EMCC resident

D, EMCC consultant

E, Anesthesia

12. The educational level of the person who tried the 2nd attempt of tracheal intubation?

A, Year 1 EMCC resident

B, Year 2 EMCC resident

C, Year 3 EMCC resident

D, EMCC consultant

E, Anesthesia

13. The educational level of the person who tried the 3rd attempt of tracheal intubation?

A, Year 1 EMCC resident

B, Year 2 EMCC resident

C, Year 3 EMCC resident

D, EMCC consultant

E, Anesthesia

14. The educational level of the person who tried the 4th attempt of tracheal intubation?

A, Year 1 EMCC resident

B, Year 2 EMCC resident

C, Year 3 EMCC resident

D, EMCC consultant

E, Anesthesia

Section II: Intubation preparation and peri-intubation events

1. Vital sign prior to intubation (blood pressure)_____
2. Vital sign prior to intubation (pulse rate)_____
3. Vital sign prior to intubation (respiratory rate)_____
4. Vital sign prior to intubation (oxygen saturation)_____
5. The method used to keep the oxygen saturation of the patient

A, Nasal prong

B, Simple facemask

C, non-rebreather facemask

D, CPAP

E, BiPAP

6. What is the indication for emergency tracheal intubation?

A, hypoxic respiratory failure

B, hypercapnic respiratory failure

C, airway protection

D, potential to deteriorate

E, transportation

7. Was the intubation a first intubation or a re-intubation (re-intubation where the patient extubated himself or extubated by a physician and re-intubation required as she/he couldn't tolerate the extubation)

A, first intubation

B, re-intubation

8. Which sequence of intubation was selected for the intubation?

A, Awake intubation

B, Delayed sequence intubation

C, Rapid sequence intubation

D, Crush intubation

9. Which of the following pre-intubation preparations were made for the patient? (more than 1 answer is possible)

A, assessment of potential airway difficulty

B, Verbalized "plan A", "plan B", "plan C"

C, Preparation of all the necessary equipment

D, appropriate positioning of the patient

E, Assigned individual roles for the team members

10. If a difficult airway was anticipated, which difficulty was anticipated in the patient?

A, Difficult BMV

B, Difficult laryngoscopy

C, difficult extra glottic device

D, Difficult cricothyroidotomy

E, physiologic difficulty

11. Which technique was used for pre-oxygenating the patient

A, non-rebreather facemask

B, Bag mask ventilation

C, CPAP

D, BiPAP

E, HFNC

F, none

12. Was apneic oxygenation using nasal prong > 15l/min applied?

A, Yes

B, No

13. Was the patient premedicated before intubation?

A, Yes

B, No

14. If your answer to the above question is "yes", please select which of the following premedications were given to the patient.

A, fentanyl

B, Lidocaine

C, Albuterol nebulization

D, Atropine

15. Was pre-treatment hemodynamic optimization done? (for those with physiologic difficulties)

A, Yes

B, No

16. If your answer to question number 15 is "yes", which of the following hemodynamic optimization options were used for the patient? (more than 1 answer is possible)

A, Isotonic saline 10-20 ml/kg

B, blood products

C, Vasopressors

17. Was paralytic given to the patient?

A, Yes

B, No

18. If your answer to the above question is "yes", which of the following paralytic drugs was given to the patient

A, succinylcholine

B, rocuronium

19. If paralytic was not given to the patient, can you specify why it was not given?

_____

20. Which of the following induction agents was used for the patient?

A, ketamine

B, propofol

C, Etomidate

D, Thiopental

E, Midazolam

F, Dexmedetomidine

F, None

21. If an induction agent was not given to the patient, can you please mention why?

_____

22. Oxygen saturation at the beginning of the first attempt of intubation?

_____

23. Which laryngoscopy was used in the patient?

A, Direct laryngoscopy

B, indirect laryngoscopy

C, video laryngoscopy

D, flexible endoscopic intubation

24. Was bougie or stylet used on the 1st attempt of tracheal intubation?

A, Yes

B, No

25. If your answer to the above question is "yes", which one of the following was used for intubation?

A, Bougie

B, stylet

26. Cormack-Lehane grade of the patient

A, Grade I

B, Grade II

C, Grade III

D, Grade IV

27. Was lifting force applied during laryngoscopy?

A, Yes (subjectively increased lifting force applied)

B, No (only little effort applied for lifting the laryngoscope)

28. Was external laryngeal pressure for optimizing glottic view (BURP maneuver) applied?

A, Yes

B, No

29. How was the position of the vocal cord on laryngoscopy visualization?

A, Abducted

B, Adducted (presenting impediment on passage of the Et tube)

30. How was ETT placement confirmed?

A, Direct visualization

B, ETCO2 (Waveform capnography)

C, Calorimetric capnography

D, Auscultation

E, Point of care ultrasound

F, radiography

Section III: Questions assessing the outcome and complications of emergency tracheal intubation

1. On which attempt was the intubation successful?

A, first attempt

B, second attempt

C, Third attempt

D, more than 3 attempts

2. How many alternative techniques of intubation after the first attempt (repositioning the patient, change of materials (like ETT, blade, stylet or bougie, laryngoscope), change of technique was used, if any

_____

3. Post-intubation Fio2?

_____

4. Post-intubation oxygen saturation?

_____

5. Post-intubation blood pressure?

_____

6. Post-intubation pulse rate?

_____

7. Was there ETT misplacement (esophageal placement), in any of the intubation attempts?

A, Yes

B, No

8. Was there any cardiovascular collapse noticed in the patient?

A, Yes

B, No

9. If your answer to question number 6 is "yes", which of the following cardiovascular collapses were evident in the patient?

A, New or increased receipt of vasopressors (between induction and 2 minutes post-intubation

B, Systolic blood pressure less than 65 mmHg (between induction and 2 minutes post-intubation

C, Cardiac arrest (between induction and 1 hour post-intubation)

D, Death (between induction and 1 hour post-intubation)

10. Which of the following endotracheal intubation complications were evident in the patient?

A, Injury to the oropharynx

B, Injury to vocal cord

C, Main stem intubation

D, Pneumothorax

E, Aspiration

F, Failed airway

G, none