Comparison of Rapid Sequence Intubation Vs Non-Rapid Sequence Intubation in Type 2 Respiratory Failure Secondary to COPD

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Abstract

Background: Airway management by rapid sequence intubation (RSI) is the most prevalent emergency endotracheal intubation procedure used in the emergency department to preserve normal respiratory function. Objective: To assess the effectiveness of rapid and non-rapid sequence intubation (RSI vs. non-RSI) in patients presented with type 2 respiratory failure secondary to chronic obstructive pulmonary disease. Methods: A quasi-experimental study was carried out at the emergency department of Ziauddin University Hospital North Campus in Karachi from March 2023 to September 2023. Consecutive sampling was used to recruit 150 adult patients with type 2 respiratory failure related to COPD who were at least 18 years old, in need of endotracheal intubation (ETI) for airway management, had a Glasgow Coma Scale (GCS) of at least 8, and could not tolerate noninvasive ventilation. Patients were randomly grouped into Group A (RSI) and Group B (Non-RSI) and treated according to standard protocol. ETI success or failure and complications during the procedure were documented. Results: Out of 150 enrolled patients, male were 76.0% (n=57) and 78.7% (n=59) and female were 24.0% (n=18) and 21.3% (n=16) with mean age of 60.6 and 62.1 years in RSI and non-RSI group respectively. In most cases the ETI was successful on the first attempt 80.0% (n=60) and 65.3% (n=49) followed by second attempt 13.3% (n=10) and 17.3% (n=13) and difficult attempt 6.7% (n=5) and 17.3% (n=13) in RSI and non-RSI group respectively. Oxygen saturation was improved in 92.0% (n=69) and 80.0% (n=60) and type 2 respiratory failure in 97.3% (n=73) and 89.3% (n=67), whereas complications were reported in 20.0% (n=15) and 34.7% (n=26) in RSI and non-RSI group respectively. Conclusion: RSI is significantly associated with higher first attempt success rates, improved oxygen saturation and type 2 respiratory failure and lower risk of complications.

Keywords: **Airway, Intubation, Emergency, Respiratory Failure, Chronic Obstructive Pulmonary Disease.**

1. Introduction

In the emergency department, respiratory failure turns out to be a medical emergency because in respiratory failure respiratory system fails to function normally [1]. Normally, the respiratory system acts as a two-way door of the body, i.e. supplying oxygen and removing carbon dioxide. Failure of the respiratory system to provide adequate oxygen results in hypoxemia (type 1 respiratory failure), whereas failure to remove carbon dioxide results in hypercapnia (type 2 respiratory failure) [2, 3].

Conventionally, respiratory failure is characterized as hypoxemia with or without hypercapnia, that is a partial pressure of oxygen (PaO_2) less than 8.0 kPa or 60 mmHg and partial pressure of carbon dioxide ($PaCO_2$) more than 6.0 kPa or 45 mmHg in the arterial blood [4, 5]. Globally, epidemiology of respiratory failure is poorly documented due to uneven and varied diagnostic criteria. Globally, its annual incidence is between 1.4-9.5/100,000 children and adolescents with mortality rate of 24%-34% [6, 7].

Chronic obstructive pulmonary disease (COPD), a common pulmonary disorder that causes respiratory failure in adults, is the third leading cause of death in the world [8]. Pneumonia, heart failure and bronchitis are the primary causes of type 2 respiratory failure in COPD patients. Despite the availability of mechanical ventilator support, patients with type 2 respiratory failure have an in-hospital mortality of

doi.org/10.31838/hiv23.04.22 Received: 12.10.22, Revised: 02.11.22, Accepted: 05.12.22.

approximately 30%. The overall mortality rate declined to 10.0% from 26.0% in patients presented with respiratory failure due to COPD, whereas the mortality rate from an acute exacerbation of COPD is about 30% [9, 10].

In respiratory failure, early and adequate airway management is critical to save life. Endotracheal intubation (ETI) is the gold standard in the emergency department to secure the airway. ETI can be performed by emergency physicians and anesthesiologists, with or without medication. The most popular technique for intubating emergency patients is rapid sequence intubation (RSI); which is associated with significantly higher success and lower complication rates [11].

In RSI patients, endotracheal tube is inserted after administration of induction agent as well as paralytic agent while in case of non-RSI, endotracheal tube is inserted with or without sedative agent. The success rate of ETI in emergencies can be increased and the risk of complications can be reduced by choosing the right intubating technique i.e. RSI and non-RSI Despite the clinical importance of RSI and non-RSI methods, data are limited to compare their effectiveness [11-15].

Therefore, we compare the effectiveness of RSI vs. non-RSI in patients presented with type 2 respiratory failure due to COPD.

2. Methodology

A quasi-experimental study was carried out at the emergency department of Ziauddin University Hospital North Campus in Karachi. During the six-month study period from March 2023 to September 2023, 150 consecutive patients from the hospital's emergency department were enrolled. The study includes the patients of (1) both gender, (2) 18 years of age or older, (3) type two respiratory failure due to COPD, (4) need ETI (RSI or non-RSI), (5) Glasgow Coma Scale (GCS) score of 8 or less and (6) patients who were unable to cope with non-invasive ventilation. The study excludes the patients of (1) cardiac arrest, (2) complete upper airway obstruction, (3) trauma, (4) surgical cricothyroidotomy, (5) multiple ETI attempts with different techniques such as switching the ETI approach between RSI and non-RSI or vice versa, (5) flexible fiberoptic intubation, (6) blind nasal intubation and (7) who received paralytics only for intubation.

A respiratory failure patient was diagnosed on presence of dyspnea, tachypnea, fatigue or cyanosis and PaO_2 less than 8.0 kPa or 60 mmHg and $PaCO_2$ more than 6.0 kPa or 45 mmHg in the arterial blood on arterial blood gas (ABG) test and pulse oximetry. Type 2 respiratory failure was diagnosed on presence $PaCO_2$ more than 6.0 kPa or 45 mmHg and pH of less than 7.35.

RSI intubation was performed by administering induction agent as well as paralytic agent while non-RSI intubation was performed with or without sedative agent. An ETI attempt was confirmed by inserting a laryngoscope blade through the teeth into the mouth or oropharynx. Successful ETI was confirmed on the stethoscope-confirmed presence of breath sounds on both sides of the chest and pulse oximetry confirming an oxygen saturation of at least 94%. Successful ETI on 1st attempt, 2nd attempt and 3rd or more attempt was confirmed and labelled 1st attempt intubation, second attempt intubation and difficult intubation respectively. Improvement in oxygen saturation was confirmed on presence of oxygen saturation of at least 94% on pulse oximetry. Improvement in type 2 respiratory failure was confirmed on presence of $PaCO_2$ less than 6.0 kPa or 45 mmHg and pH of more than 7.35. ETI associated complications were confirmed on presence of cardiac arrest (dysrhythmia, pulseless electric activity or asystole with non-measurable blood pressure BP), hypotension (BP of less than 90 mmHg), hypoxemia (oxygen saturation of less than 90% on pulse oximetry), regurgitation (esophageal contents expelled via the mouth), esophageal intubation (endotracheal tube placement in esophagus), lip or dental trauma (because of hard metallic blade) and airway trauma (larynx, pharynx or esophagus).

Study approval was obtained via letter no: 0000 from Ziauddin University Hospital Karachi. Written consent was also obtained from patients after explaining objectives and benefits of the study. Demographics, vitals, GCS score and presenting complaints of each patient were obtained. Patients were distributed into RSI and non-RSI group by using chit method.

In RSI group intubation was performed by administering induction agent (Ketamine or Propofol or Midazolam) followed by paralytic agent (Succinylcholine or Atracurium) while in non-RSI group intubation was performed with or without sedative agent (Ketamine or Propofol or Midazolam) based on the clinical status of the patient and the physician's decision.

PaO_2 and $PaCO_2$ were monitored continuously by pulse oximeter and measured before and after intubation. ETI attempt, improvement in PaO_2 and $PaCO_2$ and complications were observed as outcome. Statistical package for social sciences (SPSS) version 25 was used for statistical analysis. Quantitative and qualitative variables were presented in form of mean ± standard deviation or Median [IQR] and frequency and percentages respectively. Post-stratification chi-square test was applied by using p-value of equal or less than 0.05 as significant.

3. Results

Out of 150 enrolled patients, male were 76.0% (n=57) and 78.7% (n=59) and female were 24.0% (n=18) and 21.3% (n=16) with mean age of 60.6 and 62.1 years in RSI and non-RSI group respectively. Mean GCS score was 10.2 ± 3.3 and 11.1 ± 3.6 in RSI and non-RSI group respectively. The most commonly reported clinical symptom was dyspnea in 100% of patients in both groups, followed by fatigue in 94.7% (n=71) and 93.3% (n=70), tachypnea in 81.3% (n=61) and 90.7% (n=68) and cyanosis in 28.0% (n=21) and 36.0% (n=27) 6 in RSI and non-RSI group respectively (Table 1).

The most commonly reported induction agent was midazolam 74.7% (n=56) and 60.0% (n=45) in RSI

and non-RSI group respectively while the most commonly reported paralytic agent was Atracurium 98.7% (n=74) in RSI group (Table 2).

In RSI and non-RSI group, mean PaO_2 was 57.7 ± 8.6 and 55.9 ± 7.0 mmHg which increased significantly (p-value <0.001) to 71.4 ± 9.2 and 67.8 ± 7.4 mmHg before and after ETI respectively. Similarly, mean $PaCO_2$ was 87.8 ± 11.9 and 94.4 ± 7.1 mmHg which increased significantly (p-value <0.001) to 68.9 ± 10.5 and 74.9 ± 7.5 mmHg before and after ETI respectively (Table 3).

In most cases the ETI was successful on the first attempt 80.0% (n=60) and 65.3% (n=49) followed by second attempt 13.3% (n=10) and 17.3% (n=13) and difficult attempt 6.7% (n=5) and 17.3% (n=13) in RSI and non-RSI group respectively. Oxygen saturation was improved in 92.0% (n=69) and 80.0% (n=60) and type 2 respiratory failure in 97.3% (n=73) and 89.3% (n=67) in RSI and non-RSI group respectively (Table 4).

ETI associated complications were reported in 20.0% (n=15) and 34.7% (n=26) in RSI and non-RSI group respectively. Most commonly reported ETI associated complication was dental or lip trauma in 66.7% (n=10) and 88.5% (n=23) followed by hypotension in 86.7% (n=13) and 65.4% (n=17) in RSI and non-RSI group respectively (Table 5).

Table 1: Characteristics of 150 Patients Receiving RSI and non-RSI Intubation

Characteristics		RSI	Non-RSI
Gender	Male	57 (76.0%)	59 (78.7%)
	Female	18 (24.0%)	16 (21.3%)
Age (Years)	Mean ± SD (Years)	60.6 ± 11.4	62.1 ± 9.3
	≤ 50 Years	16 (21.3%)	10 (13.3%)
	> 50 Years	59 (78.7%)	65 (86.7%)
Vitals	Temperature (°C)	39.1 ± 10.3	38.2 ± 4.7
	Pulse (beats/min)	123.1 ± 24.4	126.8 ± 17.7
	Systolic Blood Pressure (mmHg)	131.1 ± 43.6	129.5 ± 42.4
	Diastolic Blood Pressure (mmHg)	78.6 ± 26.7	72.7 ± 24.3
	Respiratory Rate (breaths/min)	29.8 ± 9.1	35.7 ± 5.5
GCS	Mean ± SD	10.2 ± 3.3	11.1 ± 3.6
Sign & Symptoms	Dyspnea	75 (100.0%)	75 (100.0%)
	Cyanosis	21 (28.0%)	27 (36.0%)
	Tachypnea	61 (81.3%)	68 (90.7%)
	Fatigue	71 (94.7%)	70 (93.3%)

Table 2: Drugs Used During RSI and non-RSI Intubation

Drugs		RSI	Non-RSI
Induction Agent	No Agent	0 (0.0%)	6 (8.0%)
	Midazolam	56 (74.7%)	45 (60.0%)
	Propofol	13 (17.3%)	18 (24.0%)
	Ketamine	6 (8.0%)	6 (8.0%)
Paralytic Agent	No Agent	0 (0.0%)	75 (100.0%)
	Atracurium	74 (98.7%)	0 (0.0%)
	Succinylcholine	1 (1.3%)	0 (0.0%)

Table 3: ABGs in RSI and non-RSI Intubation

ABGs		RSI	Non-RSI	P-Value
PaO_2	Before ETI	57.7 ± 8.6	55.9 ± 7.0	0.178
	After ETI	71.4 ± 9.2	67.8 ± 7.4	0.010
	Paired Sample P-Value	<0.001	<0.001	
$PaCO_2$	Before ETI	87.8 ± 11.9	94.4 ± 7.1	<0.001
	After ETI	68.9 ± 10.5	74.9 ± 7.5	<0.001
	Paired Sample P-Value	<0.001	<0.001	

Table 4: Outcome of RSI and non-RSI Intubation

Outcome		RSI	Non-RSI	P-Value
Successful Attempt	First Attempt	60 (80.0%)	49 (65.3%)	0.043
	Second Attempt	10 (13.3%)	13 (17.3%)	0.469
	Difficult Attempt	5 (6.7%)	13 (17.3%)	0.044
Oxygen Saturation	Improved	69 (92.0%)	60 (80.0%)	0.034
	Not-Improved	6 (8.0%)	15 (20.0%)	
Type 2 Respiratory Failure	Improved	73 (97.3%)	67 (89.3%)	0.050
	Not-Improved	2 (2.7%)	8 (10.7%)	

Table 5: ETI Complications in RSI and non-RSI Intubation				
Complications		RSI	Non-RSI	P-Value
Complications	Yes	15 (20.0%)	26 (34.7%)	0.044
	No	60 (80.0%)	49 (65.3%)	
Type of Complications	Hypotension	13 (86.7%)	17 (65.4%)	0.138
	Hypoxemia	8 (53.3%)	8 (30.8%)	0.154
	Dental or Lip Trauma	10 (66.7%)	23 (88.5%)	0.090
	Regurgitation	0 (0.0%)	17 (65.4%)	<0.001
	Airway Trauma	0 (0.0%)	7 (26.9%)	<0.001

4. Discussion

One of the most popular emergency department ETI procedures to preserve normal respiratory function is RSI. Effective management of RSI is critical to saving the lives of patients who present to the emergency department with respiratory failure due to COPD. Despite the clinical importance of RSI and non-RSI methods in emergency, data are limited to compare their effectiveness [16, 17].

Therefore, this study was designed in the emergency department of Ziauddin University Hospital Karachi. The study's outcomes emphasize successful ETI especially in first attempt, improvement in oxygen saturation and type 2 respiratory failure and risk of ETI associated complications in RSI and non-RSI.

In this study, no significant differences were observed between the RSI and non-RSI groups in terms of demographics. Out of 150 enrolled patients, male were 76.0% (n=57) and 78.7% (n=59) and female were 24.0% (n=18) and 21.3% (n=16) with mean age of 60.6 and 62.1 years in RSI and non-RSI group respectively.

Previous similar studies have also identified a higher incidence of type 2 respiratory failure in male patients with an average age of 60 years, such as; ***Okubo M, et al.*** [18] reports the 62% and 59% male patients in RSI and non-RSI group respectively with mean age of 61 years, ***Sohal AS, et al.*** [19] reports the 70% and 60% male patients with mean age of 55.5 and 62.5 years in noninvasive ventilation (NIV) and invasive mechanical ventilation (IMV) group respectively, Patel NB, et al. [20] reports the 60% male patients with mean age of 59 years and Liu A, et al. [21] reports the 55.5% and 61.1% male patients with mean age of 69.4 and 69.8 years in high-flow nasal cannula (HFNC) group and non-invasive positive-pressure ventilator (NIPPV) group respectively.

In this study, most cases of ETI were successful at the first attempt 80.0% (n=60) and 65.3% (n=49) in RSI and non-RSI group respectively. Previous similar studies have also indicated a higher first-attempt success rate in the RSI group than in the non-RSI group. A study by Okubo M, et al. reports the first attempt successful ETI in 73% and 63% patients in RSI and non-RSI group respectively [18].

Another study by Sagarin MJ, et al. reports the first attempt successful ETI in 78% and 47% patients in RSI and non-RSI group respectively. Another study by Walls RM, et al. reports the first attempt successful ETI in 82% and 81% patients in RSI and non-RSI group respectively. Another study by Kim C, et al. reports the first attempt successful ETI in 87.2% and 71.3% patients in RSI and non-RSI group respectively [23, 24].

Another study by Muñoz ÁM, et al. [25] reports the first attempt successful ETI in 90.5% patients in RSI group. There are a number of reasons why the RSI method is said to be more successful than the non-RSI method. Research revealed that intubations with RSI provide better intubating conditions—such as abducted vocal cords, lack of vocal cord movement, ease of laryngoscopy and absence of cough reflex—than intubations with sedatives alone [18, 22-25].

In this study, mean PaO_2 was 57.7 ± 8.6 and 55.9 ± 7.0 mmHg before ETI which increased significantly (p-value <0.001) to 71.4 ± 9.2 and 67.8 ± 7.4 mmHg after ETI in RSI and non-RSI group respectively. Oxygen saturation was improved in 92.0% (n=69) and 80.0% (n=60) in RSI and non-RSI group respectively. Similarly, mean $PaCO_2$ was 87.8 ± 11.9 and 94.4 ± 7.1 mmHg before ETI which increased significantly (p-value <0.001) to 68.9 ± 10.5 and 74.9 ± 7.5 mmHg after ETI in RSI and non-RSI group respectively. Type 2 respiratory failure was improved in 97.3% (n=73) and 89.3% (n=67) in RSI and non-RSI group respectively. ETI associated complications were reported in 20.0% (n=15) and 34.7% (n=26) in RSI and non-RSI group respectively. Most commonly reported ETI associated complication was dental or lip trauma in 66.7% (n=10) and 88.5% (n=23) followed by hypotension in 86.7% (n=13) and 65.4% (n=17) in RSI and non-RSI group respectively.

Previous similar studies have also indicated a higher improvement in oxygen saturation and type 2 respiratory failure after ETI in the RSI group than in the non-RSI group. Different studies also reported a lower rate of complications associated with ETI in the RSI group than in the non-RSI group such as Okubo M, et al. 12% and 13%, Sagarin MJ, et al.1% and 5%, Walls RM, et al.11% and 16% and Muñoz ÁM, et al. 9% in RSI group. Our results also showed a very low percentage of complications in RSI group, indicating the better functioning of RSI [18, 22-25].

The main advantage of this study was the high rate of successful ETI at the first attempt with a minimal number of complications. The level of experience and expertise of the emergency physicians and the appropriateness of the RSI procedure had a significant impact on the study results. Our study's strength was that it compared the effectiveness of RSI and non-RSI in patients with type 2 respiratory failure due to COPD; however, weaknesses were a small sample size and lack of follow-up after discharge for survival.

References

Summers C, Todd RS, Vercruysse GA, Moore FA. Acute respiratory failure. Perioper Med. 2022:576.

Haddad M, Sharma S. Physiology, Lung. 2023 Jul 20. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan.

Mirabile VS, Shebl E, Sankari A, Burns B. Respiratory failure in adults. [Updated 2023 Jun 11]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan.

Vasques F, Slattery M, Srivastava S, Camporota L. Management of acute respiratory failure. Medicine. 2023 Oct;51(11):813-9.

Slattery M, Vasques F, Srivastava S, Camporota L. Management of acute respiratory failure. Medicine. 2020 Jun 1;48(6):397-403.

Hernández-Corredor L, Plazas-Pachón R, Argote-Bolaños F, Barrera-Lopez P, Vanegas MN, Moreno-Lopez S, et al. Burden of respiratory failure in pediatric patients: analysis of a prospective multicenter cohort in Bogotá, Colombia. Health Sci Rep. 2023 Nov;6(11): e1617.

Vargas Muñoz SM, De Vivero Haddad S, Beltran AM, Bonilla Gonzalez C, Naranjo Vanegas M, Moreno-Lopez S, et al. Incidence, etiology, sociodemographic and clinical characterization of acute respiratory failure in pediatric patients at a high-altitude city: A multicenter cohort study. Front Pediatr. 2022 Dec 15;10:1009375.

Chen S, Kuhn M, Prettner K, Yu F, Yang T, Bärnighausen T, et al. The global economic burden of chronic obstructive pulmonary disease for 204 countries and territories in 2020–50: a health-augmented macroeconomic modelling study. Lancet Glob Health. 2023 Aug 1;11(8):e1183-93.

Akbaş T, Güneş H. Characteristics and outcomes of patients with chronic obstructive pulmonary disease admitted to the intensive care unit due to acute hypercapnic respiratory failure. Acute Crit Care. 2023 Feb 27;38(1):49-56.

Kaynar AM, Pinsky MR. Respiratory Failure. Medscape; 2020.

Frat JP, Ragot S, Coudroy R, Constantin JM, Girault C, Prat G, et al. Predictors of intubation in patients with acute hypoxemic respiratory failure treated with a noninvasive oxygenation strategy. Cri Care Med. 2018 Feb 1;46(2):208-15.

Gökhan TA, Algin A, Özdemir S, Erdoğan M. Prospective observational study of the endotracheal intubation complications in emergency department. J Exp Clin Med. 2021 Sep 10;38(4):678-81.

Driver BE, Klein LR, Prekker ME, Cole JB, Satpathy R, Kartha G, et al. Drug order in rapid sequence intubation. Acad Emerg Med. 2019 Sep;26(9):1014-21.

Alvarado AC, Panakos P. Endotracheal Tube Intubation Techniques. [Updated 2023 Jul 10]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan.

Muñoz ÁM, Estrada M, Quintero JA, Umaña M. Rapid intubation sequence: 4-year experience in an emergency department. Open Access Emerg Med. 2021 Oct 14:449-55.

Schrader M, Urits I. Tracheal Rapid Sequence Intubation. 2022 Oct 10. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2024 Jan–. PMID: 32809427.

Fujishima S. Guideline-based management of acute respiratory failure and acute respiratory distress syndrome. J Intensive Care. 2023 Dec;11(1):1-9.

Okubo M, Gibo K, Hagiwara Y, Nakayama Y, Hasegawa K; Japanese Emergency Medicine Network Investigators. The effectiveness of rapid sequence intubation (RSI) versus non-RSI in emergency department: an analysis of multicenter prospective observational study. Int J Emerg Med. 2017 Dec;10(1):1.

Sohal AS, Anand A, Kaur P, Kaur H, Attri JP. Prospective comparative evaluation of noninvasive and invasive mechanical ventilation in patients of chronic obstructive pulmonary disease with acute respiratory failure type II. Anesth Essays Res. 2021 Jan-Mar;15(1):8-13.

Patel NB, Jain G, Chauhan U, Bhadoria AS, Chandrakar S, Indulekha H. Evaluating diaphragmatic dysfunction and predicting non-invasive ventilation failure in acute exacerbation of chronic obstructive pulmonary disease in India. Acute Crit Care. 2023 May;38(2):200-8.

Liu A, Zhou Y, Pu Z. Effects of high-flow nasal cannula oxygen therapy for patients with acute exacerbation of chronic obstructive pulmonary disease in combination with type II respiratory failure. J Int Med Res. 2023 Jun;51(6):3000605231182558.

Sagarin MJ, Chiang V, Sakles JC, Barton ED, Wolfe RE, Vissers RJ, et al. Rapid sequence intubation for pediatric emergency airway management. Pediatr Emerg Care. 2002 Dec;18(6):417-23.

Walls RM, Brown III CA, Bair AE, Pallin DJ, Near II Investigators. Emergency airway management: a multi-center report of 8937 emergency department intubations. J Emerg Med. 2011 Oct 1;41(4):347-54.

Kim C, Kang HG, Lim TH, Choi BY, Shin YJ, Choi HJ. What factors affect the success rate of the first attempt at endotracheal intubation in emergency. Emerg Med J. 2013;30(11):888-92.

Muñoz ÁM, Estrada M, Quintero JA, Umaña M. Rapid intubation sequence: 4-year experience in an emergency department. Open Access Emerg Med. 2021 Oct 14; 13:449-455.