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PROSPECTIVE OBSERVATIONAL STUDY OF ENDOTRACHEAL INTUBATION PRACTICE AND COMPLICATIONS IN ICU

Anaesthesiology

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ABSTRACT

Tracheal intubation is a critical procedure in the intensive care unit (ICU) and is often associated with significant risks, including difficult intubation and complications such as hypoxia and cardiovascular collapse. Our study aimed to assess the practices surrounding tracheal intubation within our institution and identify methods to enhance safety and minimize complications. This was a prospective observational study carried out from April 2023 to Oct 2024 after obtaining Institutional Ethics Committee approval at tertiary care center. Total 200 patients were enrolled in this study with mean age was 42 years. About 61% patients found in the age group of 38-77 years. Trauma & Poor GCS was the most common reason for intubation in 39.5% cases. In this study for propofol Dose Range was found to be 1.5 to 2 mg/kg were used in 59.5% cases from 40-120mg range. Scoline is the most commonly used neuromuscular blocking agent in this dataset, with 88.5% of cases utilizing it. There was no significant association between pre-oxygenation status and Desaturation during intubation. There was significant association between inducing drug and inotropic drug with hypotension. There was no significant association between type of laryngoscope and successful laryngoscopy. About 5.5% of cases experienced oral trauma or bleeding, 3.5% had teeth injury or bleeding and aspiration. With this study findings we conclude that, trauma and poor GCS, respiratory failure with or without shock were the leading reasons for endotracheal intubation.

KEYWORDS

Tracheal intubation, ICU, Complications

INTRODUCTION

As anaesthesiologists, securing the airway during both emergency and elective situations remains a fundamental responsibility, whether inside or outside the operating theatre. Tracheal intubation is a critical procedure in the intensive care unit (ICU) and is often associated with significant risks, including difficult intubation and complications such as hypoxia and cardiovascular collapse. Our study aimed to assess the practices surrounding tracheal intubation within our institution and identify methods to enhance safety and minimize complications. Our findings reaffirm that tracheal intubation in the ICU is a high-risk procedure with considerable morbidity and mortality. Up to 40% of intubations are complicated by marked hypoxemia or hypotension[1]. The physiological differences between ICU patients and those undergoing intubation in the operating room necessitate tailored approaches. Operator-related factors, such as experience and training, significantly impact the intubation process. Patient-related factors, including anatomically difficult airways and physiological limitations such as hypoxemia and hemodynamic instability, further complicate the procedure. The issue of inadequate fasting due to the acute nature of patients' presentations also exacerbates these challenges. Environmental factors, including limited space, poor lighting, suboptimal bed characteristics, and the presence of numerous monitors, can hinder the proper positioning and assessment of the patient's airway. These conditions often impair direct visualization of the glottis with direct laryngoscopy, increasing the difficulty of intubation and the associated complication rates. Our study supports the use of video laryngoscopy and neuromuscular blocking agents as effective strategies to ease intubation in both the ICU and emergency settings. Preoperative airway assessment is crucial for identifying difficult airways, particularly in elective inductions in the OR (Operating Room). However, in the ICU every airway may present as a difficult airway due to the various physiological factors associated with critically ill patients, such as sepsis, multiorgan dysfunction syndrome, lung injury, and ionotropic support. Thus, the choice and dosing of inducing drugs must be carefully planned and titrated to maintain hemodynamic stability. For patients who are already desaturating and have poor oxygen reserves, techniques such as high-flow nasal cannula (HFNC), non invasive ventilation (NIV), and nasal prongs are vital in preventing severe desaturation and extending apnea safety time. Our study highlights that patients receiving oxygen through these methods exhibit improved outcomes and reduced complication rates. The availability of advanced suction techniques, including the SALAD (Suction Assisted Laryngoscopy and Airway Decontamination) strategy, has been shown to optimize intubation techniques further. Additionally, having more than two anaesthetists present can facilitate smoother intubation processes in the ICU. Assistance with Sellick's manoeuvre during rapid sequence intubation (RSI) and supervision of trainees are essential for ensuring successful outcomes. This study underscores the importance of reviewing and improving our institution's practices regarding endotracheal intubation. By analysing our methods and techniques, we aim to develop an intubation bundle that enhances safety and reduces complications. Our findings contributed for establishing best practices for airway management in the ICU and inform future protocols to prevent airway mishaps.

Methodology

This was a prospective observational study carried out from April 2023 to Oct 2024 after obtaining Institutional Ethics Committee approval at tertiary care center. Minimum twenty different types of complications can occur during endotracheal intubations in the ICU as explained in the methodology and from previous studies. like hypotension, desaturation, arrythmias, tachycardia, mechanical damage to teeth, mucosa etc. At least ten patients need to be observed for each complication. Hence for this thesis study of practice pattern of endotracheal intubations in ICU, minimum 200 patients were calculated as sample size.[2] After obtaining informed written consent, patients aged > 18- 90 years requiring tracheal intubation in Perioperative ICU, Trauma ICU, CVTS Recovery, Neurosurgery ICU, ASI Grade I-V were enrolled in this study by convenient sampling method.

Under normal circumstances, whenever patient in ICU requires intubation, depending on the emergency of intubation the following steps are taken. Standard monitoring, supine or slight head up position, RT suction, oral suction, preoxygenation, assistance for cricoid, bag mask ventilation or NIV, selection of inducing drugs, with or without relaxant as per consultant discretion, choice of direct or video laryngoscope, intubating aids availability. Airway is secured and confirmed with capnography. Management of postintubation sequelae, like hypotension and or desaturation is taken care of and all this data was recorded. The intubating doctor recorded all data on specifically designed form immediately after tracheal intubation in ICU.

Basic descriptive statistical analysis using chi square test has been applied, to compare complications and incidence of outcome between the groups. Univariate analysis has been applied to find out factors causing the complications. We considered p value of <0.05 as significant.

RESULTS

Total 200 patients were enrolled in this study with mean age was 42 years. About 61% patients found in the age group of 38-77 years. Before intubation the majority of patients were put on Non-Rebreathing Mask (NRBM) with reservoir bag (63.5%). Number of patients requiring inotropic support which were hemodynamically

unstable before intubation were 21%. Maximum number of patients were in hypovolemic shock (9.5%) due to blood loss due to trauma. About 38% of patients were found to be having a difficult airway. (Table 1)

Trauma & Poor GCS was the most common reason for intubation in 39.5% cases. (Fig 1) In this study for propofol Dose Range was found to be 1.5 to 2 mg/kg were used in 59.5% cases from 40-120mg range. (Fig 2) Scoline is the most commonly used neuromuscular blocking agent in this dataset, with 88.5% of cases utilizing it. (Fig 3)

The majority of intubations were performed in the Trauma ICU (50.5%). Saturation before intubation <9% were found in 23% patients. bout 79.5% intubations were immediate within short period of time considering the need for securing airway to prevent further mishaps. Preoxygenation was planned in 95% of patients. About 17.0% of cases experienced desaturation during intubation. In this study majority of intubations (66.0%) were performed by third-year residents, with second-year residents performing 30.0% of the cases. Cricoid pressure (Sellick's manoeuvre) was used in only 7.0% of cases. (Table 2)

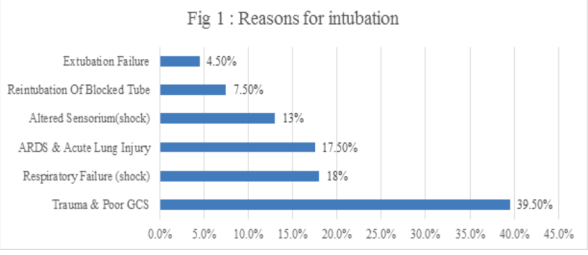
There was no significant association between pre-oxygenation status and Desaturation during intubation. (Table 3) There was significant association between inducing drug and inotropic drug with hypotension. (Table 4) There was no significant association between type of laryngoscope and successful laryngoscopy. (Table 5)

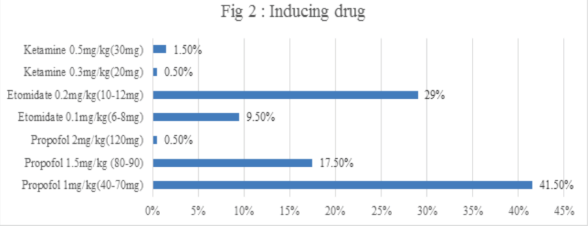
About 5.5% of cases experienced oral trauma or bleeding, 3.5% had teeth injury or bleeding and aspiration. (Fig 4)

There was significant association between difficult airway and use of FRUVA. (Table 6)

Table 1: Distribution of Patients According to Clinic-social Data

Clinic-social data		Frequency	Percentage
Age group	18-37	61	30.5
	38-47	41	20.5
	48-67	50	25
	68-77	41	20.5
	≥78	7	3.5
Oxygen therapy before intubation	NRBM	127	63.5
	RA	39	19.5
	VCAC	15	7.5
	HM	11	5.5
	NIV CPAP	8	4
Inotropic Support	Yes	42	21
	No	158	79
Shock	Hypovolemic	19	9.5
	Neurogenic	17	8.5
	Septic	4	2
	Cardiogenic	2	1
	No shock	158	79
Difficult Airway	Yes	76	38
	No	124	62





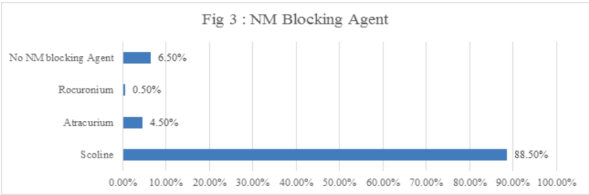


Table 2: Distribution of Patients According to Pre-intubation & During Intubation Data

		Frequency	Percentage
Place of Intubation	Trauma ICU	101	50.5
	SOTRR	75	37.5
	CVTS ICU	15	7.5
	Neuro ICU	9	4.5
Pre-intubation Saturation	<70%	4	2
	<80%	2	1
	<90%	40	20
	>90%	154	77
Urgency of intubation	Immediate	159	79.5
	Urgent <30 Min	38	19
	Semi-elective >30 Min	3	1.5
Pre-oxygenation status	High flow Oxygen	183	91.5
	NIV CPAP	5	2.5
	HFNC	2	1
	No preoxygenation	10	5
Desaturation during intubation	Yes	34	17
	No	166	83
Intubating Person	First Year	1	0.5
	Second Year	60	30
	Third Year	132	66
	SR	2	1
	Lecturer	5	2.5
Cricoid Pressure (Sellick's Manoeuvre)	Yes	14	7
	No	186	93

Table 3: Association Between Pre-oxygenation Status and Desaturation During Intubation

Pre-oxygenation status	Desaturation During intubation		p Value
	Yes	No	
High flow Oxygen	29(15.8%)	154(84.2%)	0.4
NIV CPAP	1(0%)	4(80%)	
HFNC	1(50%)	1(50%)	
No preoxygenation	3(30%)	7(70%)	

Table 4: Association Between Clinical Parameter and Hypotension

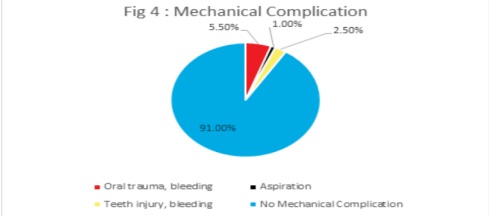
Clinical Parameter		Hypotension		p Value
		Yes	No	
Inducing Drug	Propofol	5(26.3%)	114(63%)	0.0006
	Etomidate	12(63.25)	65(35.9%)	
	Ketamine	2(10.5%)	2(1.1%)	
Inotropic support	Yes	13(68.4%)	29(16%)	<0.00001
	No	6(31.6%)	152(84%)	

Table 5: Association Between Type of Laryngoscope and Successful Laryngoscopy

Type of laryngoscope	Successful Laryngoscopy		p Value
	Yes	No	
VDL	82(73.2%)	30(26.8%)	0.396
DL	69(78.45)	19(21.6%)	

Table 6: Association Between FRUVA used and Difficult Airway

Difficult Airway	FRUVA used		p Value	Odds Ratio	CI
	Yes	No			
Yes	68(89.5%)	8(10.5%)	0.00001	12.75	6.48-25.06
No	12(9.7%)	112(90.3%)		0.161	0.09-0.27



DISCUSSION

Our study focused predominantly on trauma and post-surgical ICUs, with most intubations performed in the Trauma ICU (50.5%) & SOTRR (Surgery operation theatre recovery room) (37.5%), Cardiovascular Thoracic Surgery (CVTS) ICU (7.5%) and Neuro-ICU (4.5%). In contrast, Ruvini et al [3]'s study encompassed a wider range of settings, ICU (68%), Resuscitation room (14%), surgical wards (12%), Emergency treatment unit (ETU) (6%). This indicates that our study had a more focussed scope on ICUs whereas Ruvini et al26 included a broader variety. Similarly, Ayalew Zewdie et al [4]. focused on trauma 123(48%) patients managed in an emergency department setting. In our study most of (66%) intubations were done by third year resident under supervision. Similarly, In Ruvini et al26.'s study (84%) of intubations were performed by trained anaesthetist. ICU is area where intubations have to be done under supervision and they have to be done by trained anaesthetist in order to decrease complication rate.

In our study, main indication for intubation was found to be poor GCS in trauma patients. In Ruvini et al [3] study, reason for intubation was found to be clinical deterioration of patient condition (80%), change of blocked ET tube (8%) failed extubation and accidental extubation combined 6%. In Ayalew Zewdie et al27 study, primary indications for intubation were for airway protection 160 (62.5%), followed by respiratory failure 72(28.1%).

Preoxygenation play very crucial part mainly in ICU patients mainly because these patients are already with poor oxygen reserve capacity and they not only have anatomical difficult airway but also physiological difficult airway (hypoxemia, hypotension, acidosis, cardiac dysfunction). Preoxygenation helps them to maximally increase their safe apnea time during intubation, preoxygenation either in the form of high flow oxygen through Non rebreathing mask (NRBM), Hudson mask (HM), high flow nasal cannula (HFNC), non-invasive mask (NIV) helps to decrease the complication like hypoxemia and desaturation during the attempts of intubation. In our study, high-flow oxygen (Non rebreathing mask) was used for maximum preoxygenation in 183 patients out of which 29 patients experienced desaturation. In our study total 17% (34) patients experienced desaturation out of which 31 patients experienced desaturation even after preoxygenation and during intubation this could be prevented by offering apenic oxygenation through nasal cannula, HFNC, NIV etc in our patients. This is very important part of intubation bundle which needs to be incorporated. In our study 46(23%) patients were hypoxemic (saturation <90%) before intubation out of which 34(17%) patients experienced desaturation. Preoxygenation helped these patients (12) & did not desaturate, only 34 continued to desaturate. In 5% patients we did not preoxygenated it mainly because patients in emergency settings sometimes comes with very altered sensorium, irritable and drowsy so in such patients it may not be possible to attempt preoxygenation specially in trauma ICU. We had 17.5% patients with ARDS and acute lung injury and 18% with respiratory failure so even if we were preoxygenating it was less likely their alveoli would have opened up or their pathology would have been solved that could be the reason for 17% desaturation found in our study. Ruvini et al [3] also found the similar findings. In G.D. Simpson's et al [2] study, severe hypoxemia (SpO_2 <80%) was observed in 22% of patients with 405 experiencing SpO_2 below 90% before intubation, three quarter ware receiving > 60% oxygen, after intubation number of patients with Spo2 <805 doubled. In Ayalew Zewdie's et al27, Hypoxia was most common complication. This study suggested proper preoxygenation with and apenic oxygenation as part of intubation bundle in order to prevent desaturation during intubation and also first pass success rate. In Kumaresh P. Tamilarasu et al [5].'s study reported a significantly higher desaturation rate of 34.6% (270 out of 780 cases), with hypoxemia identified as the most common complication during intubation. Most common indication for intubation was found to be oxygen failure in 40% cases followed by poor GCS 35%cases before intubation. The choice of induction agents and neuromuscular blocking agents differed among studies.

Our study showed predominant use of propofol (59.5%) and etomidate (38.5%) as induction agents, with ketamine being used in only 2% of cases. In comparison, Ruvini et al26. reported a higher usage of midazolam (58%) and lower usage of propofol (34%), ketamine in (14%). Ayalew Zewdie et al [4]. found that ketamine was the most frequently used induction agent due to the unavailability of etomidate, these variations reflect regional practices, drug availability, and institutional protocols, demonstrating how local contexts shape clinical practice.

In our study, the occurrence of hypotension post-intubation was seen in 9.5% of the cases. One key factor contributing to the lower incidence of hypotension (9.5%) in our study could be maximum number of our patients were in young age groups 18–35 year age group 30.5%, 38–47-year age group was 20.5% and lesser were in geriatrics age group 68–77-year age group 20.5% & 78 and above year age group was only 3.5%. Also, we used lower doses of induction agents in maximum number of patients which were given slowly in graded form, Propofol 1mg/kg was used in 41.5% patients and Etomidate 0.1 mg/kg in 9.5% patients. We used these titrated doses because 21% of our patients were in shock & hemodynamically unstable. When we further compared in our study, it was found that Etomidate which was cardiostable drug used in 77 patients out of which 12 patients still had hypotension which was statistically significant (p value=0.0006) than propofol which was used in 119 patients & only 5 had hypotension. This could be because of around 30% patients were received 0.2mg/kg of etomidate non titrated & also etomidate is primarily given in geriatrics patients who could be having ischemic heart disease so geriatrics patients with higher dose of etomidate probably caused hypotension in patients associated with different kinds of shocks in trauma as well as post operative critical care ICU. The association between the use of ionotropic support and the occurrence of hypotension further highlights the complexity of managing these patients. In my study, out of 42 patients who received ionotropic support before intubation 13 had hypotension compared to only 158 of those who did not receive such support 6 had hypotension. In our study out of 19 patients who had hypotension after intubation 13 patients were already on ionotropic support which were hemodynamically unstable. This significant association ($p<0.0001$) underscores the need for careful monitoring and management of patients with hemodynamic instability, particularly those requiring ionotropic support. In Kumaresh P. Tamilarasu et al29.'s study mean age was 46.7 years, reported a lower overall hypotension rate of 5.2% (41 out of 780 cases). In 36% patients midazolam+fentanyl was used and in 25% patients ketamine was used, propofol+fentanyl used in 19.4%. Midazolam was used in 0.1-0.2mg/kg dose, propofol 1-2mg/kg, fentanyl 3microgram/kg.

Our study showed a first-pass success rate of 73.2% with VDL and 78.4% with DL, whereas in Azam et al [6] study, first attempt between VDL & DL was found to be 81.5% & 68%r respectively. Use of advanced equipment's like VL scope is necessary to visualise especially difficult airway, in patients with restricted neck mobility, in trauma patients with cervical spine fracture. VL scope has some advantages like improved Cormack lehane grading view. Intubation becomes a teamwork rather than single person intubating. Certain VL scopes can be used in restricted mouth opening which can be part of intubations of ICU patients & mechanical damage also less compared to DL scope because of better viewing angle. VL scope learning span is also shorter compared to DL scope, so eventually VL scope should be the part of intubation bundle. Every intensivist learnt and skilled to use VL scope over DL scope in ICU patients.

In our study, the most commonly used neuromuscular blocking agent was succinylcholine (Scoline) at 88.5% in 1-1.5mg/kg doses. Similarly, in Ruvini et al26 study, succinylcholine used in 84% patients. In our study 76 patients had difficult airway (38%), intubating aids were used in 84 patients like fruva, bougie and stillete to reduce the number of attempts and for ease of intubation. Intubating aids were not used in 116 patients. Critically ill patients in ICU are already associated with poor oxygen reserve they not only have anatomical but physiological difficult airway so they are very prone to desaturation during intubation, so intubating aids helps us to decrease number of attempts of intubations and faster intubation within short span of time by most experienced person doing the intubation. In kumaresh et al [5] Study, stillete was used in 17.1% and bougie was used in 15.5% intubations. Intubating aids were used in lesser proportion compared to other studies. Cricoid pressure (Sellick's manoeuvre) is the pressure applied on cricoid cartilage externally which compresses esophagus and prevents aspiration of gastric contents. Cricoid pressure usage varied considerably across studies. In our study, cricoid pressure was applied in only 7% of cases and in 2 cases aspiration was seen. In our study maximum number of patients (around 88%) NBM (Nil by mouth) status was found to be >6hr that could be the reason for lesser number of aspirations in our study. In our study modified RSI (Rapid sequence induction) technique were used in with positive pressure ventilation were not given before intubation so, chances of aspiration were less. Another reason why we used cricoid pressure in a smaller number of patients was most of our intubation were done in night time

during emergency hours. In Ruvini et al [3]. Study in 66% cases cricoid pressure was used and aspiration was noted in 6% cases there was no proven benefit was found of application of cricoid pressure.

CONCLUSION

With this study findings we conclude that, trauma and poor GCS, respiratory failure with or without shock were the leading reasons for endotracheal intubation. While advanced tools like Video Laryngoscope (VDL) has been used maximum in our ICU & it is the future of endotracheal intubation practice in critical care. The study also highlights the need for appropriate management strategies to prevent & deal with complications like hypotension, desaturation and to incorporate as part of intubation bundle.

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