

A Retrospective Study Evaluates Tracheal Intubation Procedures and Complications in Trauma Patients

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Abstract

Aim: To investigate the tracheal intubation procedures and complications in trauma patients upon their arrival at a tertiary hospital

Material and Method: This study was conducted in the Department of Anesthesia, Patna Medical College and Hospital, Patna, Bihar, India for one year. Data was collected on all tracheal intubations occurring in trauma victims requiring definitive airway control with endotracheal intubation in red (life threatening injury requiring immediate emergency care) and yellow (do not have life threatening injury/do not require immediate emergency care) area of trauma triage.

Results: On arrival, 436/527 (82.7%) intubations were considered urgent and 426/527 (80.8%) intubations were attempted by first responders (general surgery residents (PG resident 3/4 semester)), the most common indications were low GCS score and failure to protect the airway. Around 48/426 (9.1%) intubations were reported as challenging, and on-call, anaesthesia resident was summoned to reattempt intubation. During intubation, in a majority of patients, (509 (96.5%)) SpO₂ was monitored using pulse oximetry, whereas blood pressure measurement was done for 420 (79.6%) patients. Haemodynamic instability was present in 73/527 (13.8%) patients prior to the intubation attempt. Peri-intubation hypotension was documented in 99 (23.57%) patients out of 420 patients. Similarly, hypoxaemia during intubation was documented in 21.21% (108/509) patients.

Conclusion: The trauma triage is a high-volume area for frequent tracheal intubations which is manned by non-anaesthesia speciality teams. A number of factors related to the patient, staff, availability of airway equipment and unfavourable surroundings impact airway management and may explain the high incidence of airway complications, such as airway injuries in these trauma victims.

Keywords: Tracheal intubation, Trauma, Arrival

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Introduction

Tracheal intubation is a critical intervention in the management of trauma patients, often performed in emergency settings to secure the airway, facilitate ventilation, and prevent aspiration. The procedure, however, is fraught with challenges and potential complications, particularly in trauma victims who may present with complex injuries, altered anatomy, or physiological instability. Trauma remains a leading cause of morbidity and mortality worldwide, necessitating prompt and effective airway management to ensure patient survival and optimize outcomes. [1,2] Tracheal intubation is often the preferred method for airway management in trauma patients due to its ability to provide definitive airway control. The indications for tracheal intubation in trauma victims include

compromised airway patency, inadequate ventilation or oxygenation, altered mental status, and the need for general anaesthesia during surgical interventions. [3,4] The practices of tracheal intubation in trauma settings have evolved with advances in medical technology and training. Rapid Sequence Intubation (RSI) is the most commonly employed technique, combining rapid administration of a sedative and a neuromuscular blocking agent to facilitate quick and efficient intubation while minimizing the risk of aspiration. [5,6] The use of video laryngoscopy has become increasingly prevalent, providing enhanced visualization of the vocal cords and potentially improving intubation success rates. Prehospital intubation performed by emergency medical services (EMS) personnel plays a crucial role in the

early management of trauma patients. Studies have shown that prehospital intubation can improve oxygenation and reduce the time to definitive care, although it also carries risks of complications if performed under suboptimal conditions. In-hospital intubation, typically carried out in the emergency department or operating room, benefits from a controlled environment and the availability of advanced airway management tools and personnel. [7,8] Despite its critical importance, tracheal intubation in trauma victims is associated with a range of adverse events, which can significantly impact patient outcomes. Hypoxemia is one of the most common complications, often resulting from prolonged intubation attempts or inadequate preoxygenation. Hypotension, which can exacerbate traumatic brain injury and other critical conditions, is another frequent adverse event, often due to the hemodynamic effects of sedatives and the transition to positive pressure ventilation. Failed or difficult intubation presents a significant risk, particularly in trauma patients with challenging airway anatomy due to facial injuries, cervical spine immobilization, or oedema. The incidence of difficult intubation is higher in trauma patients compared to non-trauma populations, necessitating the presence of experienced personnel and alternative airway management strategies. Oesophageal intubation, where the endotracheal tube is mistakenly placed in the oesophagus, is a potentially fatal complication that can lead to severe hypoxia and cardiac arrest if not promptly recognized and corrected. This underscores the importance of confirming tube placement using capnography and other verification methods. [9-11]

Material and Methods

This study was conducted in the Department of Anesthesia, Patna Medical College and Hospital, Patna, Bihar, India for one year. Written and informed consent was obtained from immediate legal relatives of eligible patients. Data was collected on all tracheal intubations occurring in trauma victims requiring definitive airway control with endotracheal intubation in red (life threatening injury requiring immediate emergency care) and yellow (do not have life threatening injury/do not require immediate emergency care) area of trauma triage. We excluded patients who were intubated before arrival in trauma triage, any missed documentation of intubation events, and incomplete data. The data was collected by an independent observer who was not a part of data analyses. To minimise any missed intubations, different methods were adopted by the personnel responsible for the collection of data. These methods included a discussion with the staff performing and assisting the intubation, regular meetings with the trauma team during the end of each shift, and also during handover to the subsequent team and finally through the review of trauma

ma triage records. Data were collected using specific proformas both for anaesthetists and speciality residents (neurosurgery, orthopaedics, cardiovascular thoracic surgery, and plastic surgery). An anaesthesia resident [postgraduate (PG)1] (with more than six months of training experience and minimum experience of 20 intubations) was considered to be an expert. We recorded the demographic profile of the patients, diagnosis, along with indication for intubation, mode of injury, presence of any head injury, drugs and equipment used for intubation, personnel performing intubation, number of attempts, and complications during intubation. As per institutional practice, all patients received a fluid bolus of 500 ml crystalloid when received with trauma in the triage area, and before attempting intubation and giving drugs to prevent haemodynamic instability.

Airway injuries included observation for lip, oropharyngeal, dental, and vocal cord trauma. Bradycardia was defined as heart rate (HR) ≤ 40 /min or 20% decrease in pre-intubation HR; hypotension was considered when systolic blood pressure (SBP) ≤ 90 mm Hg and significant hypoxaemia was defined as peripheral oxygen saturation (SpO₂) value $< 90\%$ during intubation attempt. Visualisation of newly regurgitated contents or the bleed due to trauma during suction via endotracheal tube was considered as aspiration. [8]

Use of rapid sequence intubation (RSI) or manual in-line stabilisation whenever performed were recorded. [9,10] Urgent intubations were defined as the immediate requirement of intubation, difficult intubations were those requiring ≥ 3 attempts of intubation, attempts taking > 10 minutes, or need for an airway adjunct or another airway manager. Failed intubation was defined as failure to place an endotracheal tube after multiple attempts (≥ 3 attempts). [5] Completed proformas were collected on a daily basis. The triage registry was reviewed for any missed documentation of intubation events.

Statistical analysis was carried out using International Business Machines Statistical Package for the Social Sciences (IBM SPSS Inc, Chicago, version 21.0). *P* value $< 0.05\%$ was considered statistically significant with 95% confidence interval.

Results

The trauma triage registry recorded a total of 12,916 trauma patients during the 12 months study period out of which 1,236 patients required endotracheal intubation. On arrival, 436/527 (82.7%) intubations were considered urgent and 426/527 (80.8%) intubations were attempted by first responders (general surgery residents (PG resident 3/4 semester)), the most common indications were low GCS score and failure to protect the airway. Around 48/426 (9.1%) intubations were reported as challenging, and on-

call, anaesthesia resident was summoned to reattempt intubation. As primary responders, anaesthesia residents performed 101/527 (19.1%) intubations. Preoxygenation was done in 80% (422/527) patients. All intubations were carried out on a stretcher with head position in extension in 64.3% (339/527); neutral in 28.8% (152/527); neutral with manual in line stabilisation in 2.27% (12/527) and sniffing position in 13.6% (72/527) patients. All patients were monitored using pulse oximetry and non-invasive blood pressure, but due to non-availability, electrocardiogram and end tidal

carbon dioxide were not recorded. The adequacy of surrounding space was another technical issue, with adequate space in 96 cases (18.2%), whereas, in the rest of the cases the surrounding area was occupied by patient relatives and trollies.

The most common mode of injury was road traffic accidents in 459 (87.1%) cases. GCS scores of the patients at the time of intubation ranged from 3-15 with a median of 8. The most common reason for intubation was a low GCS score in 361 (68.5%) patients, followed by respiratory distress in 108 (20.5%) cases [Table 3].

Table 1: Demographic data of trauma victims requiring intubation

Parameter	Patients n=527*
Age (years)	32 (22-45) **
Male/female	398/129*
Type of injury	
Head injury	415 (78.7%) *
Blunt trauma chest	133 (25.2%) *
Blunt trauma abdomen	103 (19.5%) *
Cervical spine injury	17 (3.2%) *
Facial burns	15 (2.8%) *
Faciomaxillary injury	5 (0.9%) *
Isolated bone fractures	5 (0.9%) *

During intubation, in a majority of patients, (509 (96.5%)) SpO₂ was monitored using pulse oximetry, whereas blood pressure measurement was done for 420 (79.6%) patients. Haemodynamic instability was present in 73/527 (13.8%) patients prior to the intubation attempt. Peri-intubation hypotension was documented in 99 (23.57%) patients out of 420 patients. Similarly, hypoxaemia during intubation was documented in 21.21% (108/509) patients. All intubations were carried out using a direct laryngoscope. The majority of intubations were done by general surgery residents (PG 4) 338/527 (64.1%) followed by anaesthesia

residents (PG 3) 115/527 (21.8%). Anaesthesia resident was present in 149 cases (101 cases as primary intubation and in 48 cases as the second intubate) for intubation [Table 4]. The first attempt success rate of intubation for general surgery residents was 63.1% (269/426) and that of anaesthesia residents was 80.5% (120/149), P = 0.0001 with 95% confidence interval (CI) 9.02-24.66. Similarly, the second attempt success rate was also higher for anaesthesia residents compared to general surgery residents, P = 0.043 (95%CI 0.23-10.46).

Table 2: Grade and speciality of 1st and 2nd intubate

Grade and speciality	1 st intubate n=527	2 nd intubate n=79
GS residents with 12 months experience	27 (5.1%)	-
GS residents with 18 months experience	338 (64.1%)	-
GS residents with 24 months experience	38 (7.2%)	15 (19.2%)
GS residents with 30 months experience	-	34 (43.5%)
Anaesthesia residents with 6 months experience	9 (1.7%)	7 (8%)
Anaesthesia residents with 12 months experience	115 (21.8%)	19 (24.3%)
SR anaesthesia	Nil	4 (3.8%)

External laryngeal manipulation during intubation was done in 315/527 cases (59.8%), the stylet was used in 383/527 (72.6%), bougie was used only by anaesthesia residents in 19 cases, three patients required placement of laryngeal mask airway as a rescue device (difficult intubation), four patients needed front of neck access, in the form of surgical tracheostomy, however in one patient surgical access also failed leading to severe hypoxaemia

and cardiac arrest. A majority (95.7%) of patients intubated by speciality residents received injection midazolam for assisting intubation; (408/426) of these, 13.48% (51/408) patients received ≥ 5 mg dose of midazolam. In patients intubated by anaesthesia residents, induction agents (thiopentone and ketamine) and muscle relaxants (succinylcholine and vecuronium) were used. Of this, rapid sequence induction (RSI) was performed

in 99/149 (66.4%) patients. Among intubations done by speciality residents, the most common adverse event was airway injury [140/426 (32.8% patients)] followed by hypotension in 58/426 (13.8%) patients. The intubations indicated for low GCS score ≤ 5 ($n = 28/120$, 23.3%) recorded lesser airway injuries than those with GCS $\geq 6-8$ ($n = 92/120$, 78.7%) [($P = 0.0001$; Chi-square test); 95% CI: 41.6-62.8]. We found a significant association between the choice of drugs used and the rate of

adverse events. In 99/149 patients who were intubated using RSI, 77% patients had no complications (77/149), followed by airway injuries in 8% (8/99), oesophageal intubation in 4% (4/99), hypoxaemia in 5% (5/99) and hypotension in 3% (3/99) patients. Complications were directly linked with the number of attempts at intubation (>2 attempts at intubation, $P = 0.0001$, 95% CI 30.2-51.7) [Table 5].

Table 3: Adverse events during intubation attempts in trauma victims by both speciality and anaesthesia residents. Data are represented as, n (%)=number of patients (percentage)

Complications	By speciality residents *n=426	By anaesthesia residents n=149
No complications	228 (53.5%)	92 (61.7%)
Airway injuries	140 (32.8%)	13 (8%)
Hypotension	57 (26.0%) **	6 (4%)
Failed intubation	48 (11.2%)	4 (2.6%)
Desaturation	42 (9%)	8 (5.3%)
Oesophageal intubation	22 (5%)	7 (4.6%)
Aspiration of blood	19 (4.4%)	3 (2%)
Aspiration of gastric contents	5 (1.1%)	1 (0.2%)

Discussion

A total of 527 patients were analysed, and out of these, 426 intubations were considered urgent. The majority of intubations (76.4%) were performed by speciality residents (general surgery) and 28.27% by anaesthesia residents. The first attempt success rate for speciality and anaesthesia residents was 63.1% and 80.5%, respectively. [12] These findings reflect the different staffing levels and the limited expertise available on arrival to trauma triage. An observational study in the emergency department of an academic centre, reported the working of various levels of health care professionals as a team. [11] Whereas, in accordance to our research, Walls *et al.* [12] reported that anaesthesiologists performed only 3% of the intubations, and the remaining 97% of the intubations were performed by emergency physicians (87%) and physicians from other specialities (10%). [13]

The level of experience for airway management requires a learning curve of 150 intubations for the success of intubation. [13] A United Kingdom based guideline suggested training for a minimum of two years in emergency specialities and at least one year in anaesthesia for airway management. [14] Ono *et al.*, [15] reported that the experience of the laryngoscopies plays a pivotal role, and hence their finding that the success rate of intubation increases when an anaesthesiologist performed intubation; this is supported by our data too.

There is an emphasis on the need for proper pre-oxygenation for successful and complication-free out-of-theatre emergency intubation. [16] The incidence of desaturation varied significantly between

speciality (12.96%) and anaesthesia residents (8.25%). It could be attributed to the higher proportion of patients pre-oxygenated in a standardised manner by anaesthesia residents. Literature supports the use of techniques like 25° head-up position or the use of non-invasive ventilation techniques, including positive end-expiratory pressure, during preoxygenation in emergency intubations. [17,18] Midazolam was used by speciality residents in 77.4% (408/527) patients, which was given in variable doses, resulting in peri-intubation hypoxia in 61/395 (15.44%) cases, hypotension in 57/395 (14.43%) cases and other airway related complications. Also, the use of midazolam for intubation is not supported by literature in emergency settings. [19] Nevertheless, the extensive use of midazolam in our environment may be due to the lack of familiarity with anaesthetic drugs among speciality residents. Most of the intubations carried out by anaesthesia residents were drug assisted along with the use of muscle relaxants which resulted in lesser complications and trauma. Literature supports the use of neuromuscular blockers in 62-77% of cases, with a strong association being reported between the use of neuromuscular blocking agents, especially depolarising agents and fewer adverse effects. [20,21] The National Audit Projects 4 data indicates that airway interventions outside the operation theatre are more likely to result in adverse events. [22] In the current study, the incidence of adverse events and complications were higher in intubations by speciality residents (46.4%), which were probably due to inexperience, improper positioning of the patient, inadequate oxygenation, absence of adequate monitoring, unfamiliarity with drug-assisted intubations and unavailability and

inexperience with the usage of airway adjuncts. Use of better and minimum standards of monitoring, including capnography are required in emergency intubations to reduce adverse events and better patient services. [23]

Recently, Russotto *et al.* [24] conducted an observational study to evaluate the incidence of adverse peri-intubation events during intubation of critically injured patients. Primary outcome included the incidence of major adverse events within 30 minutes of tracheal intubation, which included cardiovascular instability (SBP <65, or <90 for 30 minutes, increased need of vasopressors) or hypoxaemia (SpO₂ <80%) and cardiac arrest. The authors reported, 45.2% of patients experienced at least one major peri-intubation event, most common was cardiovascular instability in 42.6% of cases. In the present study, airway-related injuries were most common; the probable reason for this could be that only trauma victims were included, whereas Russotto *et al.* [24] included all critically ill patients in intensive care units.

Bougie was used only by anaesthesia residents in case of failure to intubate in the first attempt. Early and better use of airway manoeuvres and airway adjuncts (bougie) played an important role in an increased first attempt success rate of intubation in emergency areas. [25,26] Trauma triage teams should be provided with better airway adjuncts and should be made familiar with their use so as to improve patient care. Bernhard *et al.* [27] highlighted the difficulties posed in the real-world scenario with regards to equipment availability, practical issues at resuscitation bay as well as costs incurred in procuring the equipment.

Emergency cricothyrotomy is the final step in the emergency airway management algorithm. [28] Specialised training along with equipment should be available at the trauma triage centers. [29] The incidence of failed intubations requiring surgical airway was 0.75% in the current study, which was less when compared to previous studies reporting 1.7% by Ono *et al.* [15] Similarly, the incidence of cardiac arrest in our study was reported in 0.9% of patients when compared to 1.7% in the previous research. [8] But whether the cardiac arrest resulted due to patients' underlying physiological state or due to attempts at intubation could not be deciphered from the data collected.

The findings of this study support the need for the development of an emergency response system and team in emergency departments in low resource settings, regular simulation-based training in advanced trauma life support and airway management and the presence of difficult airway cart in trauma triage bay. The rate of complications can also be reduced by the adaptation of a checklist and a

standardised protocol for the formulation and usage of drugs.

Conclusion

The trauma triage is a high-volume area for frequent tracheal intubations which is manned by non-anaesthesia speciality teams. A number of factors related to the patient, staff, availability of airway equipment and unfavourable surroundings impact airway management and may explain the high incidence of airway complications, such as airway injuries in these trauma victims.

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