Airway status at arrival to the Emergency department among patients with life threatening emergencies
Sanjay Murugan, Anju S. Kurien, Kundavaram Paul Prabhakar Abhilash
Department of Emergency Medicine, Christian Medical College, Vellore, Tamil Nadu, India

ABSTRACT

Background: Despite the improvement in prehospital care in the last decade in India through dedicated ambulance services, airway management is often performed by undertained or untrained personnel and remains teetering to the edge of collapse. This study aimed at assessing the airway status in critically ill patients at their arrival to the Emergency Department (ED). Methods: This prospective study included all triage priority I patients presenting to the ED during August 2017 and September 2017. Details of their airway status at arrival to the ED was noted. The severity at presentation and outcome of patients brought in ambulances and private vehicles were determined using descriptive analytic statistics and bivariate logistic regression analysis. Results: The study included 450 patients, with a male predominance (65.3%). Only a third (31%) of patients were brought in ambulances with a reminder through various means of transport. Compared to patients brought by private vehicles, patients brought to the ED by ambulances had a higher odds of being hypoxic at ED arrival [OR: 1.63 (95% CI: 1.08–2.46); P value: 0.01] and requiring invasive ventilation on arrival to the ED [OR: 2.36 (95% CI: 1.46–3.80) P value: < 0.001]. Overall, 55.7% (248/450) required hospital admission while 21% (95/450) were discharged stable from the ED after resuscitation and stabilization by the ED team. The overall mortality rate was 11.1% (50/450), with 13.5% (19/144) of those brought by ambulances and 10% (31/309) of those brought by private vehicles succumbing to their illness in the hospital. Conclusion: Private vehicles still remain the predominant mode of prehospital transport though ambulances are used to transport sicker patients. More than half the critically ill patients remained hypoxic on arrival to the ED. Our study clearly highlights the glaring deficiency in airway status at ED arrival and stresses the urgent need to improve prehospital care.

Keywords: Airway management, Emergency department, Emergency medical services, hypoxia, pre-hospital care

Introduction
Airway is the foremost priority in the management of any critically ill patient. Airway management is the first and predominant step in Airway, Breathing, Circulation (ABC) and is a vital component in both prehospital and in-hospital setting. It is performed to provide optimal oxygenation and ventilation in airway compromised patients and thereby ensuring its patency. Prehospital airway management is always an arduous task for every Emergency Medical Service personnel worldwide and hypoxia and airway mismanagement is considered to be a significant cause of morbidity and mortality in critically ill patients being rushed to the Emergency Department (ED).[1,2] Failure to recognize a compromised airway or the need of ventilation, aspiration of gastric contents, poor patient positioning, lack of skills in airway management are some of the causes attributed to prehospital airway mismanagement.[3] Crewdson et al. found that 57% of trauma victims had a compromised airway and suffered severe hypoxic injury on arrival to the ED.[8] With advanced and efficient prehospital transport in the developed world, success rate of emergency intubation done by paramedics were equal to that of in-hospital setting.[9] However, in India, trained
road side assistance of injured patients is inadequate and many people succumb to their injuries or are shifted to the hospital with unstable airway or circulation. Improving the transport of unstable patients would help a lot in decreasing morbidity and mortality at both primary level and tertiary level hospitals.

However, prehospital care in India still remains in its infancy and is not well established. Majority of critically ill patients are transported to the ED through private vehicles and most ambulances are ill-equipped with emergency resuscitation equipment and most ambulances employ grossly undertrained emergency personnel. Hence the adequacy of airway management among critically ill patients arriving at the ED is questionable and perhaps grossly inadequate. Hence, we conducted this prospective study to assess the airway status of triage priority I patients at arrival to the ED and to compare the airway status between patients brought by ambulances and by private vehicles.

Methodology

Study design
We conducted a prospective observational study between August 2017 and September 2017 (2 months).

Study setting
After procuring the Institutional Review Board (IRB) approval, this prospective observational study was conducted in the ED of a large tertiary hospital in South India. Our ED is one of the largest in the country with 6 priority I beds and 49 beds in total with an average of 200 admissions per day.

Participants
The study cohort included critically ill patients triaged as priority I and admitted in the resuscitation room (red zone). We recruited a convenient sample of patients presenting to the resuscitation room between 8 am and 5 pm during weekdays. Due to shift duty system in the ED, it was pragmatically strenuous to enroll all priority I patients, hence our study design involved convenient sampling.

Variables
As our study was focused on assessing the airway status of triage priority I patients presenting to the ED, we selected variables representing the above domain. These included patient’s sex, number of trauma and non-trauma victims, their mode of transportation to the ED, vital signs at presentation and interventions done to secure the airway on ED arrival. Triage priority level I was defined as follows: Patient with airway, breathing, or circulation compromise or severe head injury (GCS < 8)

Outcome variables
The outcome variables include percentage of patients presenting with hypoxia to the ED, percentage of patients admitted in Intensive Care Units (ICU) and wards, discharged stable from hospital and death in hospital. The severity and outcome of patients brought by ambulances were compared to those who were brought by private vehicles (auto, car, etc.).

Sample size
Based on a pilot study done in our ED, the sample size with an expected proportion of 8%, and an absolute precision of three was calculated to be 327. However, during our 2-month study period, 450 patients fulfilled inclusion criteria and were recruited.

Statistical analysis
Statistical analysis was performed using Statistical Package for Social Sciences for Windows (SPSS Inc. Released 2007, version 23.0. Armonk, NY, USA). Categorical and nominal variables are presented as percentages and Chi-square test was used to compare dichotomous variables. The comparison of outcome of patients who presented in ambulances and private vehicles were determined by bivariate analysis and their 95% confidence intervals were calculated. For all tests a 2-sided P-value less than 0.05 was considered statistically significant.

Ethical consideration
This study was approved by the Institutional Review Board (IRB Min. No. 10322 dated 07.10.2016).

Results
During the 2-month study period, the ED attended to 14,292 patients with 12% (1640) triaged as priority 1. We recruited 450 patients with convenient sampling from 8 am to 5 pm during week days [Figure 1]. There was a male predominance (65.3%) with a mean age of 52.4 years (SD 16.4). Trauma victims comprised 9.8%. Only a third (31%) of patients were brought in ambulances with a reminder through various means of transport like auto, cars, vans, etc. The baseline characteristics and vital signs at ED arrival is shown in Table 1.

During prehospital transfer, 20.9% (94/450) received oxygen therapy through endotracheal intubation (2.7%), bag mask ventilation (1.3%), oxygen mask (16%), and nasal prongs (0.9%). We compared the vital signs and airway status at ED arrival between patients brought by ambulances and by private vehicles [Table 2] Compared to patients brought by private vehicles, patients brought to the ED by ambulances had a higher odds of being hypoxic at ED arrival [Odds ratio: 1.63 (95% CI: 1.08–2.46); P value: 0.01] and requiring invasive ventilation on arrival to the ED [Odds ratio: 2.36 (95% CI: 1.46–3.80) P value: < 0.001]. An important observation was that half (51.1%) the patients brought by private vehicles too were hypoxic at ED arrival suggesting that this mode of transport is routinely used to transport very sick patients. Forty-four priority 1 trauma victims were brought to our ED during the study period with 33 (75%) brought by ambulances and 11 (25%) brought by private vehicles. Severe head injury [Glasgow coma scale (GCS) < 8] was seen
Table 1: Demographic details of triage Priority 1 patients presenting to the ED (n=450)

| Characteristics                                      | Number (%)       |
|------------------------------------------------------|------------------|
| Mean age (SD) in years                               | 52.4 (16.4)      |
| Male                                                 | 294 (65.3)       |
| Female                                               | 156 (34.7)       |
| Trauma victims                                       | 44 (9.8)         |
| Non-trauma victims                                   | 406 (90.2)       |
| Oxygen therapy during pre-hospital transfer          | 94 (20.9)        |
| No oxygen                                            | 356 (79.1)       |
| Mode of transportation to the ED                     |                  |
| 108 (Government) Ambulance                           | 41 (9)           |
| Private ambulance                                    | 100 (22)         |
| Auto (Three wheeler)                                 | 161 (36)         |
| Other private vehicles                               | 148 (33)         |

Clinical parameters at presentation

Heart rate ≥100 beats/minute 253 (56.2)
Systolic blood pressure (SBP) <100 mmHg 98 (22)
Respiratory rate >20 breaths/min 390 (87)
SpO2 <94% 247 (55)
Low sensorium (GCS <10) 74 (16.4)

Trauma victims n=44
Mild head injury (GCS 14-15) 23 (52.3)
Moderate head injury (GCS 9-13) 9 (20.5)
Severe head injury (GCS≤8) 12 (27.2)
Mean RTS (SD) 6.62 (1.14)

GCS - Glasgow Coma Scale, RTS - Revised Trauma Score, SpO2 - Peripheral capillary oxygen saturation.

Table 2: Comparison of examination findings and severity at presentation to ED based on mode of transportation

| Characteristics                                      | Ambulance (n=141) | Private vehicles (n=309) | P     | Odds ratio (95% CI) |
|------------------------------------------------------|-------------------|--------------------------|-------|---------------------|
| Heart rate ≥100 beats/minute                         | 88 (62.4)         | 165 (53.4)               | 0.07  | 1.44 (0.96-2.17)    |
| Systolic BP <100 mmHg                                | 31 (22)           | 67 (21.7)                | 0.94  | 1.01 (0.62-1.64)    |
| Respiratory rate >20 breaths/min                     | 123 (87.2)        | 267 (86.4)               | 0.81  | 1.07 (0.59-1.94)    |
| SpO2 <94%                                            | 89 (63.1)         | 158 (51.1)               | 0.01  | 1.63 (1.08-2.46)    |
| Gasping at arrival                                   | 13 (9.2)          | 12 (3.9)                 | 0.02  | 2.51 (1.11-5.65)    |
| Oxygen therapy via various means during prehospital transport | 94 (67)          | 0                         | <0.001 | 7.57 (5.80-9.88)    |
| Intubated on arrival to ED                           | 42 (30)           | 47 (15.2)                | <0.001 | 2.36 (1.46-3.80)    |
| Tracheotomy on arrival to ED                         | 0                 | 5 (1.6)                  | 0.25  | 0.19 (0.01-3.56)    |

GCS: Glasgow Coma Scale, SpO2: Peripheral capillary oxygen saturation.

Our study showed the status of airway of severely ill patients at arrival to the ED. In Emergency medical services, prehospital care plays an eminent role in treatment and dispatch of critically ill patients from the scene to a higher center for an advanced medical care.[6,7] Airway management in prehospital care remains an indispensable task. According to the studies conducted in developed countries, various physiological and environmental barriers hinders effective prehospital airway management. However, their quality of prehospital airway management has progressed significantly because of advanced training programs and revised protocols. In India, prehospital care is still an

Discussion

The ED outcome and hospital outcome of our study patents is shown in Table 3. Overall, 55.7% (248/450) required hospital admission while 21% (95/450) were discharged stable from the ED after resuscitation and stabilization by the ED team. The overall mortality rate was 11.1% (50/450), with 13.5% (19/144) of those brought by ambulances and 10% (31/309) of those brought by private vehicles succumbing to their illness in the hospital. The breakdown of mortality and outcomes in the ED and in the hospital is shown in detail in Table 3.

Figure 1: STROBE diagram
emerging field and the adequacy in airway management among critically ill patients being transferred to the ED is controversial. Hence, we conducted a study to assess the prehospital airway management in patients presenting to resuscitation room of the ED. To the best of our knowledge, this study on the assessment of airway status at ED arrival is first of its kind in India.

Though ambulances were the fundamental mode of prehospital transport, in our study almost two-third of the critically ill patients were brought to the ED by private vehicles (auto, car, and motor bikes). Among those who were brought by ambulances, percentage of patients shifted by private ambulances were predominantly higher than the government run 108 ambulances.

As discussed earlier, prehospital airway management is the most essential and challenging component worldwide. Daniel et al. reported prehospital hypoxia and hypotension were the predominant causes of increased mortality in traumatic brain injury (TBI). The result of the other study also concluded, hypoxia to be a precipitating factor of mortality in TBI as they evidenced higher mortality rate in patients presented with both hypoxia and hypotension rather than hypotension only. In our study, in spite of patients being transported by ambulances, a higher percentage of patients were hypoxic at presentation to the ED which certainly objectifies the substandard prehospital airway management.

Due to the advanced prehospital care in the developed world, Prekker et al. witnessed 83% success rate in rapid sequence intubation (RSI) done by paramedics in the ambulances. In European countries, critically ill patients transported in the ambulances with a compromised airway were either intubated or secured with other advanced airway devices such as laryngeal mask airway (LMA) or combitube to establish patent airway whereas we found simple nasal prongs, simple face mask, and non-rebreather mask to be the most common airway devices used in the ambulances to maintain patent airway in patients with compromised airway. The reason for using low end airway devices is an obvious lack of training or absence of trained paramedics in the available ambulances. None of the above airway maneuvers can be expected to be provided or performed on patients being transported to the ED in private vehicles, which in our study was used in an alarming 70% of patients with emergencies.

Although two-third (94/141) of the patients brought by an ambulance received oxygen therapy, many remained hypoxic (70/94), as oxygen was administered without ensuring the patency of airway which indicates the lack of expertise in recognizing a threatened airway and the need for ventilation. Moreover, 19 patients who were hypoxic during their transportation in the ambulance were not initiated on oxygen therapy. Nearly one third (42/141) of the patients brought by ambulances had a compromised airway and were intubated only after arrival to the ED. The ED outcome showed more than half of the patients transported by ambulances required either ICU or ward admission and one third of patients had a bad outcome (ED death/Leaving against medical advice [LAMA]).

Understanding the significance of airway management and the consequences of hypoxia, various government and private health organizations initiated teaching programs for the public (school and college students, lay person) on basic airway skills like mouth-to-mouth-ventilation and mouth-to-nose-ventilation along with basic life support (cardio pulmonary resuscitation) so that the collapsed victim at the scene would be benefited until prehospital service arrives.

Hence our study emphasized the need of advanced and well equipped prehospital care with highly skilled and knowledgeable emergency medical services provider who is an expert in managing critically ill patients, capable of providing optimal care and establishing advanced airway and other advanced procedures during the prehospital transfer as hypoxia and airway mismanagement were one of the leading causes of prehospital mortality and morbidity.

**Limitations**

Our study accommodated only convenient sample of patients (8 am to 5 pm) as it was arduous to recruit all priority 1 patients presenting throughout 24 h to the ED. Details of prehospital airway management were not addressed in our study as we did not acquire the consent form the EMS personal in the ambulance. Hence only the presentation at ED arrival is described in our study.

| Characteristics | Ambulance (n=141) Value (%) | Private vehicles (n=309) Value (%) | P |
|----------------|-----------------------------|-----------------------------------|---|
| **ED outcome** |                             |                                   |   |
| Intensive care unit Admission | 38 (27) | 51 (16.5) | 0.010 |
| Ward Admission | 48 (34) | 111 (35.9) | 0.699 |
| Discharged stable from ED | 9 (6.4) | 89 (28.8) | <0.0001 |
| Left against medical advice | 41 (29.1) | 50 (16.2) | 0.001 |
| Died in ED | 5 (3.5) | 8 (2.6) | 0.575 |
| **Characteristics** |                             |                                   |   |
| **Hospital Outcome** |                             |                                   |   |
| Discharged | 72 (84) | 139 (86) | 0.66 |
| Died in hospital | 14 (16) | 23 (14) | 0.66 |
Conclusion

Though nearly one third of the critically ill patients were brought by ambulances, many remained hypoxic on arrival to the ED and had a bad outcome. Thus, our study clearly highlights the glaring deficiency in the airway status at ED arrival and stresses the urgent need to improve prehospital care.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Research quality and Ethics statement

The authors of this manuscript declare that this scientific work complies with reporting quality, formatting, and reproducibility guidelines set forth by the EQUATOR Network. The authors also attest that this clinical investigation was determined to require Institutional Review Board/Ethics Committee review, and the corresponding protocol/approval number is IRB Min. No. 10322 dated 07.10.2016. We also certify that we have not plagiarized the contents in this submission and have done a Plagiarism Check.

References

1. Berlac P, Hyldmo PK, Kongstad P, Kurola J, Nakstad AR, Sandberg M, et al. Pre-hospital airway management: Guidelines from a task force from the Scandinavian Society for Anaesthesiology and Intensive Care Medicine. Acta Anaesthesiol Scand 2008;52:897-907.
2. Leach RM, Treacher DF. Oxygen transport-2. Tissue hypoxia. BMJ 1998;317:1370-3.
3. Khan RM, Sharma PK, Kaul N. Airway management in trauma. Indian J Anaesth 2011;55:463-9.
4. Crewdson K, Rehn M, Lockey D. Airway management in pre-hospital critical care: A review of the evidence for a 'top five' research priority. Scand J Trauma Resusc Emerg Med 2018;26:89.
5. Jacobs PE, Grabinsky A. Advances in prehospital airway management. Int J Crit Illn Inj Sci 2014;4:57-64.
6. Abhilash KP, Chakraborty N, Pandian GR, Dhanawade VS, Bhanu TK, Priya K. Profile of trauma patients in the Emergency department of a tertiary care hospital in South India. J Family Med Prim Care 2016;5:58-63.
7. Rufus YB, Abhilash KP, Swadeepa RJ, Koshy SA, Chandy GM. Clinical profile and outcome of the patients presenting to the resuscitation room of the Emergency department in a Tertiary Care Hospital of South India. Curr Med Issues 2019;17:25-9.
8. Warner KJ, Sharar SR, Copass MK, Bulger EM. Prehospital management of the difficult airway: A prospective cohort study. J Emerg Med 2009;36:257-63.
9. Spaite DW, Hu C, Bobrow BJ, Chikani V, Barnhart B, Gaither JB, et al. The impact of combined prehospital hypotension and hypoxia on mortality in major traumatic brain injury. Ann Emerg Med 2017;69:62-72.
10. Prekker ME, Kwok H, Shin J, Carlbom D, Grabinsky A, Rea TD. The process of prehospital airway management: Challenges and solutions during paramedic endotracheal intubation. Crit Care Med 2014;42:1372-8.
11. Pennant JH, Walker MB. Comparison of the endotracheal tube and laryngeal mask in airway management by paramedical personnel. Anesth Analg 1992;74:531-4.
12. Garza AG, Gratton MC, Coontz D, Noble E, Ma OJ. Effect of paramedic experience on orotracheal intubation success rates. J Emerg Med 2003;25:251-6.
13. Wang HE, Mann NC, Mears G, Jacobson K, Yealy DM. Out-of-hospital airway management in the United States. Resuscitation 2011;82:378-85.
14. Vézina MC, Trépanier CA, Nicole PC, Lessard MR. Complications associated with the Esophageal-Tracheal Combitube in the pre-hospital setting. Can J Anaesth 2007;54:124-8.
15. Toni P, Antti K, Heini H, Silfvast T, Nurmi J, Virkkunen I, et al. Physician-staffed helicopter emergency medical service has a beneficial impact on the incidence of prehospital hypoxia and secured airways on patients with severe traumatic brain injury. Scand J Trauma Resusc Emerg Med 2017;25:94.
16. McHugh GS, Engel DC, Butcher I, Steyerberg E, Lu J, Mushkudiani N, et al. Prognostic value of secondary insults in traumatic brain injury: Results from the IMPACT study. J Neurotrauma 2007;24:287-93.
17. Gellerfors M, Fenvang E, Backman A, Kruger A, Mikkelsen S, Nurmi J, et al. Pre-hospital advanced airway management by anaesthetist and nurse anaesthetist critical care teams: A prospective observational study of 2028 pre-hospital tracheal intubations. Br J Anaesth 2018;120:1103-9.
18. Godwin HT, Fix ML, Baker O, Madsen T, Walls RM, Brown CA 3\textsuperscript{rd}. Emergency department airway management for status asthmaticus with respiratory failure. Respir Care 2020;esrcare. 07723. doi: 10.4187/esrcare.07723. Epub ahead of print. PMID: 32723860.
19. Divya B, Edacheril IG, Jacob M, Abhilash KP. Prospective observational study to assess the circulatory status of the patients presenting to resuscitation room in Emergency department. Curr Med Issues 2020;18:115-9.
20. Adhikari DD, Mahathi K, Ghosh U, Agarwal I, Chacko A, Jacob E, et al. Impact of pre-hospital care on the outcome of children arriving with agonal breathing to a pediatric emergency service in South India. J Family Med Prim Care 2016;5:625-30.