Physician-based on-scene airway management in severely injured patients and in-hospital consequences: is the misplaced intubation an underestimated danger in trauma management?

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ABSTRACT

Background Endotracheal intubation (ETI) is the gold standard for the out-of-hospital emergency airway management in severely injured patients. Due to time-critical circumstances, poor patient presentation and hostile environments, it may be prone for mechanical complications and failure.

Methods In a retrospective study (January 2011 to December 2013), all patients who underwent out-of-hospital ETI before admission to a level 1 trauma center were analyzed consecutively. Patients with supraglottic airways, being under cardiopulmonary resuscitation and interfacility transports were excluded. The main study endpoint was the incidence of unrecognized tube malposition; secondary endpoints were Glasgow Outcome Scale (GOS) and in-hospital mortality adjusted to on-scene Glasgow Coma Scale (GCS), Injury Severity Score (ISS), Abbreviated Injury Scale head (AIS head), and on-scene time.

Results Out of 1176 patients, 151 underwent out-of-hospital ETI. At hospital admission, tube malpositions were recognized in nine patients (5.9%). Accidental and unrecognized esophageal intubation was detected in five patients (3.3%) and bronchial intubation in four patients (2.7%). Although ISS (p=0.053), AIS head (p=0.469), on-scene GCS (p=0.151), on-scene time (p=0.530), GOS (p=0.748) and in-hospital mortality (p=0.431) were similar compared with correctly positioned ETI tubes, three esophageal intubation patients died due to hypoxemic complications.

Discussion In our study sample, out-of-hospital emergency ETI in severely injured patients was associated with a considerable tube misplacement rate. For safety, increased compliance to consequently use available technologies (eg, capnography, video laryngoscopy) for emergency ETI should be warranted.

Level of evidence Level of Evidence II A.

BACKGROUND

Out-of-hospital emergency endotracheal intubation (ETI) is the gold standard in severely injured patients who require advanced airway management. It represents an important skill in emergency medical service (EMS) and is recognized as a quality indicator. Due to potential risk of severe complications which includes multiple intubation attempts, inadvertent esophageal or bronchial intubation, transient hypoxia, airway edema and bleeding, and tracheal aspiration, out-of-hospital ETI is discussed controversially. The aim of our study was to determine the prevalence and outcomes of patients who experienced tube malpositioning after emergency out-of-hospital ETI due to severe injuries.

METHODS

After approval by the ethical committee of the Medical Faculty of the University Hospital Leipzig (No 137-15-20042015), we analyzed all electronic and paper-based medical charts of patients who were admitted to our university emergency department (ED) with trauma team activation between January 1, 2011 and December 31, 2013.

Investigated variables

Patient characteristics included age, gender, injury patterns, Abbreviated Injury Scale head, Injury Severity Score, Glasgow Coma Scale (GCS) on scene, and on-scene time (OST, time from EMS arrival until hospital admission). Patients <16 years, with supraglottic airways, being under cardiopulmonary resuscitation and interfacility transports were excluded. The main study endpoint was the incidence of unrecognized tube malposition (esophageal and endobronchial intubation); secondary endpoints were Glasgow Outcome Scale (GOS) and in-hospital mortality adjusted to injury severity, head injury and OST.

Setting

In Germany, out-of-hospital emergency treatment of patients with major trauma is provided by EMS physicians. In the current ‘Guideline on the Treatment of the Severely Injured’ the intubation is indicated in polytraumatized patients with apnea or snap breathing and recommended in patients with hypoxia (SpO₂<90%), a traumatic brain injury (GCS <9), a trauma-associated hemodynamic instability (RR systolic <90 mm Hg) or after severe thorax trauma with respiratory insufficiency. However, some EMS physicians perform out-of-hospital intubation in case of severe pain after major trauma. In the receiving ED, the trauma team consists of traumatologists, visceral surgeons, neurosurgeons, anesthetists and radiologists due to national recommendations. Primary and secondary surveys are performed according to advanced trauma life
support standard. All major trauma patients undergo multislice CT after focused assessment of sonography for trauma.

**Statistics**

Descriptive statistics was performed using numbers (percentage) and mean values (£±SD). Computations used SPSS V.20 (SPSS) for Windows using $X^2$ test or Fisher’s test for categorical variables. Normal distribution was tested using Student’s $t$-test or Mann-Whitney test. Differences between the two groups were calculated by using $X^2$ test for categorical variables and the $t$-test for continuous variables. The significance level was set up at $p<0.05$. Multivariate analysis was not performed due to low sample sizes.

**RESULTS**

During the 3-year study period, 1176 patients were admitted to our center and presented to our trauma team. One hundred and fifty-one patients (12.8%) underwent emergency out-of-hospital ETI by EMS physicians. Demographic data and patient’s characteristics are displayed in table 1. Context of injuries were injuries particularly recommends video laryngoscopy use and frequent training in emergency anesthesia, ETI, and alternative ways of securing an airway (including bag valve mask, supraglottic airway devices, and emergency cricothyrotomy).

Detailed neurological outcomes of patients with delayed or unrecognized tube misplacement are not available. In our study, patients who suffered from unrecognized tube misplacement had more unfavorable GOS in comparison to patients with successful airway management.

Esophageal intubation can be survived when spontaneous breathing is warranted. Due to the use of paralytics and anesthetic drugs, this may be impaired or impossible. Furthermore, the risk of tracheobronchial aspiration may be increased when the tube is removed from the esophagus. Therefore, direct laryngoscopy and ETI should be performed before esophageal placed tube removal. In four cases, the fatal esophageal misplacement was detected immediately after admission, but in one case due to spontaneous breathing despite tube obstruction the misplacement was found after a whole-body CT scan.

**DISCUSSION**

In this study, we investigated the prevalence and outcomes of tube malpositions of major trauma patients admitted to a level I trauma center after out-of-hospital ETI by EMS physicians. The incidence of misplaced ETI was 5.9% whereas esophageal misplacements are more likely to cause irreversible neurological sequelae and are often fatal due to inadvertent iatrogenic hypoxemia in contrast to mainstem bronchial misplacements. In the current literature, the reported incidence of unrecognized esophageal misplacements in out-of-hospital ETI is ranging from <1% up to 16.7% (table 4).

We did not select patients due to ISS, which can only be calculated after completion of diagnostic and thus may not be applied appropriately for acute patient triage. The study population reflected real-life presentations to the trauma team.

EMS physicians usually do not work in EMS only but attend several days per month. Thus, the performance of emergency ETI may vary considerably. EMS physicians perform ETI only once every 0.5–1.5 months depending on the type of EMS program (ground vs. helicopter EMS). The needed number of ETIs prior to the active participation in EMS is still an area of debate: studies found between 75 and 150 performed ETI as a prerequisite to reach a high first-pass success. Furthermore, video laryngoscopy showed improved intubation success rates in trauma patients. Therefore, the recently revised German guideline on treatment of patients with severe and multiple injuries particularly recommends video laryngoscopy use.

| Table 2 | Patients’ characteristics of esophageal misplacements |
|----------------|-----------------------------|
| Patient | Age | Gender | ISS | AIS head | GCS on scene | Trauma mechanism | Outcome |
| 1 | 42 | Male | 66 | 3 | 3 | Motor vehicle crash | Survived |
| 2 | 43 | Male | 16 | 4 | 3 | Fall from height | Deceased |
| 3 | 74 | Male | 38 | 3 | 15 | Motor vehicle crash | Deceased |
| 4 | 57 | Female | 57 | 3 | 11 | Fall from height | Deceased |
| 5 | 48 | Male | 43 | 5 | 12 | Fall from height | Survived |

I trauma center after out-of-hospital ETI by EMS physicians. Demographic data and patient’s characteristics are displayed in table 1. Context of injuries were injuries particularly recommends video laryngoscopy use and frequent training in emergency anesthesia, ETI, and alternative ways of securing an airway (including bag valve mask, supraglottic airway devices, and emergency cricothyrotomy). Detailed neurological outcomes of patients with delayed or unrecognized malpositioned tubes are not available. In our study, patients who suffered from unrecognized tube misplacement had more unfavorable GOS in comparison to patients with successful airway management.

| Table 3 | Use of medication, blood gas analysis and evidence of anoxia |
|----------------|-----------------------------|
| **No** | **Anesthesia medication** | **Blood gas analysis** | **Evidence of misplacement** |
| 1 | Midazolam, fentanyl | pH 7.18, pCO$_2$ 50.3, pO$_2$ 205.4, BE –9 | Capnography in trauma room |
| 2 | Etomidate, propofol | pH 7.17, pCO$_2$ 55.1, pO$_2$ 80.2, BE –7 | Whole-body CT scan |
| 3 | Propofol, midazolam, fentanyl, succinylcholin | pH 7.28, pCO$_2$ 68.0, pO$_2$ 443, BE 2.5 | Capnography in trauma room |
| 4 | Piritramid | pH 7.11, pCO$_2$ 47.1, pO$_2$ 64.9, BE –10 | Capnography in trauma room |
| 5 | Hypnomidate propofol, morphin | pH 7.16, pCO$_2$ 52.4, pO$_2$ 255, BE –9 | Capnography in trauma room |
Patients in a physician-based out-of-hospital EMS setting. We found a considerable incidence of unrecognized misplacement of endotracheal tubes in our whole study collective and patients in the successful intubation group may have had more frequent use of video laryngoscopy. We did not particularly analyze the training levels of EMS physicians regarding ETI performance, which may have varied considerably. However, we present real-world data with all strengths and weaknesses.

CONCLUSION

We found a considerable incidence of unrecognized misplacements of endotracheal tube emergency ETI of severely injured patients in a physician-based out-of-hospital EMS setting. Further studies should be warranted to develop strategies for an improved ETI performance of EMS providers by consequent application of available technologies.

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