

Airway managed by emergency physicians or anaesthesiologists in trauma patients: A retrospective cohort analysis of outcomes

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Abstract

Objectives In some trauma centres, anaesthesiologists (AN) has the primary responsibility of managing airway in trauma resuscitation. However, as emergency physicians (EP) establishes a separate specialty with airway management and endotracheal intubation being one of the core skills, role delineation within trauma members may vary. In this cohort study, we aim to determine the difference in mortality of trauma patients requiring intubation in the Emergency Department between EP and AN.

Methods We screened all 1588 patients in the hospital trauma registry from 2015 to 2018. We included all patients requiring endotracheal intubation and aged 18 or above but excluded those with pregnancy, presented with cardiac arrest and secondarily transferred from other hospitals. 349 eligible patients were sorted into two cohorts according to the physicians who performed intubations (AN 205 patients, EP 144 patients). Patients' baseline demographics, 30-day all-cause mortality, and other predefined secondary outcomes were compared by statistical tests. Stepwise logistic regression of 30-day all-cause mortality were performed.

Results Our study has shown that intubation by emergency physicians was not associated with higher 30-day all-cause mortality after potential confounders were controlled by logistic regression. (adjusted OR 1.253, $p = 0.607$) Both group also did not differ in other clinical important secondary outcomes, including proportion of successful intubations, use of surgical airway or rescue manoeuvres, respiratory and airway complications, mortality in intensive care or high-dependency unit, post-intubation cardiac arrest, post-intubation hypotension and post-intubation hypoxia.

Conclusion Endotracheal intubation by EP is not associated with increased 30-day all-cause mortality when compared to AN after accounting for confounders.

Introduction

Background

Polytrauma is a life threatening condition requiring multidisciplinary care. Many trauma centres adopt a "Trauma Resuscitation Team" (TRT) approach. The exact composition of the TRT varies from centre to centre. There are differences in practice with respect to whom should manage the airway in trauma patients.

Traditionally, anaesthesiologists (AN) have the primary responsibility for airway management in most centres.[1] However, with emergency medicine being established as a distinct specialty and airway management being one of the core skills [2-5], emergency physicians (EP) routinely perform advanced airway management in the emergency department (ED) [5-8].

Previous observational studies have not demonstrated any differences in the outcome of trauma patients with airway managed by EP versus AN. [9-11] Locally, we do not have any study comparing outcome of

intubation by EP versus AN in trauma resuscitation.

Airway management in trauma resuscitation is always challenging. The risk of rapid airway compromise is a common and important reason for early intubation in patients with direct airway trauma. EPs have the privilege of being the first to attend the patient and opportunity to timely manage the airway at risk.

Objectives

Our primary objective is to determine the difference in mortality of trauma patients requiring intubation between EP and AN. We also aim to identify the difference in other important outcome differences and also potential contributory factors of mortality. Secondary outcome and complications which may explain the mortality difference are identified. Potential contributory factors to mortality are also studied.

Methods

Study design

This is a registry-based unmatched cohort study. We identified trauma patients requiring intubation during resuscitation in the ED, then extracted relevant trauma related parameters and outcome data from the trauma registry of the hospital and patients' health records. The reporting of this study is in compliance of the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement. [12] Ethical approval was sought from Research Ethics Committee, Kowloon Central Cluster, Hospital Authority of Hong Kong (KC/KE-18-0232/ER-3).

Setting

This study was conducted in a trauma centre in Hong Kong. The centre is one of the five trauma centres in the region and it is also a regional tertiary and quaternary referral centre with full complements of clinical services. Daily ED attendance of the centre is around 500 patients. As a designated trauma centre, our unit receives primary trauma diversions from ambulance service and also secondary trauma diversion from other regional hospitals. Yearly major trauma (injury severity score (ISS) >15) attendance is around 300.

In this hospital, TRT composes of specialist EP and trauma surgeons. Anaesthesiologists and other subspecialties will be consulted according to the injury pattern. The decision to solicit help from anaesthesiologists for airway management is at the discretion of the attending EP specialist.

Participants

The hospital trauma registry captures any patients who met TRT activation criteria (see appendix), who were triaged as critical or emergency in the ED (triage guideline), who died (excluding death prior to arrival to ED) and were admitted to intensive care units (ICU)/high dependency units (HDU). Injury and outcome data were prospectively collected and entered into the registry.

We screened all patients requiring endotracheal intubation in the ED from the trauma registry of the centre during the period of 1st Jan 2015 to 31 Dec 2018. Patients were included if age 18 or above. Pregnant patients were excluded, as well as those presented with cardiac arrest or transferred from other hospitals.

Subjects recruited were sorted into two cohorts according to the specialty (EP or AN) providing trauma airway management.

Variables

Our primary outcome is 30-day all-cause mortality.

Secondary outcomes include 1) proportion of successful intubations, 2) need of surgical airway or 3) rescue manoeuvres 4) respiratory or airway complications, 5) ICU and HDU mortality, 6) post-intubation cardiac arrest, 7) post-intubation hypotension and 8) post-intubation hypoxia.

Rescue manoeuvres was defined as any use of laryngeal mask airway or bronchoscopic intubation instead of direct laryngoscopy or video laryngoscopy. Airway and respiratory complications is a composite outcome defined as any ventilator-associated pneumonia (VAP)/ hospital-acquired pneumonia (HAP) or tracheostomy for prolonged intubation. HDU/ICU mortality is defined as mortality during ICU/HDU care. Post-intubation cardiac arrest was defined as any cardiac arrest during resuscitation in the emergency department after injection of induction and/or paralytic agents whichever was earlier. Post-intubation hypotension was defined as the first systolic blood pressure(SBP) after placement of endotracheal tube less than 90mmHg before leaving ED. Post-intubation hypoxia was defined as the lowest pulse oxygen saturation (SpO₂) after placement of endotracheal tube less than 93% before leaving ED.

Patients' demographic data including age, gender and comorbidities were also collected. Comorbidities included AIDS, cirrhosis, diabetic mellitus, hepatic failure, immunosuppression, leukemia/myeloma, Non-Hodgkin's lymphoma, solid tumor with metastasis, chronic respiratory condition. The definition of these conditions follows the definition used in Apache IV score(12). Renal failure was defined as patient requiring renal replacement therapy (peritoneal dialysis or hemodialysis). Data on patients requiring long term residential care (Elderly home, etc) was also collected. Clinical variables collected included vital signs (blood pressure, oxygen saturation and Glasgow coma scale), duration of ED resuscitation, time to intubation, base excess, emergency operations (including three-in-one procedure for pelvic fracture, laparotomy, neurosurgery, closed or open reduction with fixation, or others), activation of massive transfusion protocol, presence of neck collar, trauma diversion status and TRT activation status. Duration of ED resuscitation is the duration between patient transferred in and out of resuscitation room. Time to intubation is the time from ED registration to injection of paralytic agent. If no paralytic agent was used, time of recording first vital signs documented after intubation was used.

Mechanism of trauma was grouped into three categories, namely burns, low energy trauma (such as fell from height less than 2 metres, or penetrating injuries), and high energy trauma (such as fell from height more than 2 metres or motor vehicles accidents). Trauma related scores (Probability of survival [1998], Injury Severity Score (ISS), Revised Trauma Score (RTS) were also extracted for analysis.

We were particularly interested in chest trauma, head, neck and facial trauma which may predict intubation difficulty. As such, we have extracted the maximum abbreviated injury scale (MAIS) from the registry, by analysing the body region code of 1, 2, 3, 4 and 6 (head, face, neck, chest and spine) of the Abbreviated Injury Scale (AIS) separately. Spinal injuries other than cervical spine were excluded.

Data Sources and Measurements

Clinical and laboratory data were retrieved from the trauma registry and the Clinical Management System (CMS) via the clinical data analysis and reporting system (CDARS) of the Hospital Authority. Patient's case notes were also accessed to retrieve data and ascertain diagnosis. The trauma registry was also the source of trauma related data, such as clinical parameters during ED resuscitation, mechanism of injuries and injury severity scores, namely, AIS, ISS and RTS. The outcomes (mortality/survival) and interventions given during pre-hospital, ED resuscitation and inpatient period were also retrieved.

Diagnosis of ventilator associated pneumonia and hospital acquired pneumonia were based on the diagnosis made by the treating physicians.

Coding of the ISS and AIS were performed by an experienced trauma nurse specialist trained in the AIS coding.

Bias

In addition to the inherent bias in a retrospective study, we noted that EPs were found to intubate more patients with isolated head injury. It is well known that probability of survival of severely head injured patients is poorer when compared with that of patients with other system injuries having the same ISS. There are also many parameters showing baseline imbalance. Hence a planned logistic regression was performed to control for confounding factors resulted from differences in trauma severity and pattern.

Study size

Based on a cursory review of trauma registry data of the year 2017. There were a total of 107 intubated patients. Mortality among these patient were 53.5% and 29.7% when the airway were managed by emergency physician (EP) versus Anaesthesiologists (AN) respectively.

Based on the above observation, the required sample size were found to be around 195, according to the Fleiss equation with continuity correction, taking power (1-beta) of 90% and alpha of $p < 0.05$. [15] To achieve the expected the sample size, we have screened the trauma registry data from 2015 to 2018.

Quantitative Variables

In this study, the following grouping of quantitative variable were performed prior to analysis.

MAIS more than 2 in each of the body regions were considered as serious. This is based on the definition of the abbreviated injury score.

Patient with ISS > 15 is considered as suffering from major trauma, as customary in trauma researches.

Statistical methods

IBM SPSS Statistics Version 25, Microsoft Excel version 16.23 and Apple Inc. Numbers were used to handle calculation and data analysis.

Patient demographics were reported with descriptive statistics, using mean, median and standard deviations (SD) and interquartile range (IQR). Normality of continuous variables were tested with Shapiro-Wilk Test. Difference between normal variables were analyzed with Student's t tests while non-normal variables were managed with Mann Whitney's sign rank tests. Categorical outcome variables such as 30-day all-cause mortality were analyzed with the Chi-square tests or Fisher-Freeman-Halton-exact tests.

Missing data would be managed with multiple imputations, using missing at random assumption. The multiple imputation function of SPSS were used to impute 10 sets of complete dataset by the Markov Chain Monte Carlo method. The maximum number of parameters in imputation model was set to 10. Each dataset were then inspected by two authors for consistence. Then the pooled averaged values from the 10 sets will be used for analysis.

We carried out a multivariable logistic regression to control for any potential confounding and interaction. Baseline characteristics with potential difference ($P < 0.25$) were included in the univariate regression analysis (Table 3). Statistical outcomes are to be regarded as significant if P is < 0.05 , adjusted odd ratios would be reported.

Analyzing the missing data by listwise deletion were planned as a sensitivity analysis.

Results

Participants

We screened all patients (1588 patients) in the trauma registry of the centre from 2015 to 2018. 365 (23.0% of 1588 patients) patients age 18 or above were found to require intubation in the ED. Among them, sixteen patients were excluded, including fourteen patients presented with cardiac arrest and two patients transferred from other hospitals. (see Flowchart)

349 patients were included in the final analysis. 205 patients (58.7%) were intubated by anaesthesiologists while 144 patients (41.3%) were intubated by emergency physicians.

Descriptive Data

The two cohort differ in many aspects in baseline characteristics. (Table 1)

The EP group tends include older patients than anaesthesiologists (Median age 65.5 vs 58, $p = 0.001$). While anaesthesiologists intubated all burns patients ($n=11$) in the whole cohort.

Anaesthesiologists intubated more patients with serious chest trauma (41.0% vs 20.8%, $p<0.0005$) and presence of a neck collar (86.1% vs 72.2%, $p=0.001$). Both group did not differ in severity of neck trauma, cervical spine trauma and facial trauma.

Anaesthesiologists group had higher proportion of activation of massive transfusion protocol (23.9% vs 13.2%, $p=0.013$), primary trauma diversion (51.2% vs 38.9%, $p=0.023$) and activation of the hospital TRT (92.7% vs 42.4%, $p<0.0005$). More patients in AN group received three-in-one procedures for pelvic fracture (16.1% vs 6.9%, $p=0.010$), laparotomy (9.3% vs 3.5% , $p=0.035$), closed reduction or open reduction and internal fixations (6.3% vs 0.7%, $p=0.008$).

While EP intubated more patients with serious head injury (77.1%vs 66.3%, $p=0.030$), the median Glasgow coma scale in the AN group is also significantly better than the EP group (8 vs 5.5, IQR 3-12 vs 3-9, $p= 0.001$). However, both group did not differ significantly in receiving brain operations (25.4% vs 33.3% $p=0.105$) and other operations (10.2% vs 5.6%, $p=0.118$).

Anaesthesiologists intubated patients with lower pre-intubation SBP (mean 141.16 vs 156.47, $p=0.001$) and lower first recorded SpO₂ (median 99% vs 100%, IQR 94.75-100 vs 97.75-100, $p = 0.005$) but received shorter duration of resuscitation in the ED (median 60 mins vs 70 mins, IQR 50-75 vs 59.25-85, $p <0.0005$). Other clinical parameters such as first SBP and diastolic blood pressure (DBP), first pulse, pre-intubation DBP and laboratory parameter such as base excess did not differ in both cohorts.

Overall, the EPs handled more severely head injured and older patients, while the AN handled patients who are likely to be in shock and bleeding.

The following baseline variables has missing data : First recorded SpO₂ 1.43%, pre-intubation SBP and DBP 0.86%, pre-intubation SpO₂ 3.43%, first base excess 6.3%.

Outcome Data

Among the 349 trauma patients requiring intubation in ED during the study period. 67 (32.7%) in AN group died within 30 days of hospitalisation while 69 patients (47.9%) died in EP group (Table 2).

As for the secondary outcomes, the number of successful intubations of AN and EP group were 100%, need of surgical airway were 0% while rescue manoeuvres were 0.5% vs 0%.

23.4% of AN group patients developed respiratory and airway complications while 20.1% of EP group patients did. Mortality in ICU or HDU was 20.0% in AN group and 16.7% in EP group. 3.9%, 10.7% and 8.4% of AN group patients versus 2.8%, 6.9% and 7.7% of EP group patients developed post-intubation

cardiac arrest, post-intubation hypotension and post-intubation hypoxia respectively. Both group did not differ significantly in secondary outcomes. (Table 2)

The following outcome variables has some data missing : post-intubation hypoxia 0.86%.

Main Results

Primary Outcomes

Intubation by emergency physicians was associated with higher unadjusted 30-day all-cause mortality (relative risk 1.466, 95% CI 1.130-1.901, $p=0.004$). (Table 2)

Controlling of potential confounding factors

Logistic regression was performed to adjust for baseline imbalance and potential confounding factors for our primary outcome, 30-day all-cause mortality. Univariate analysis had showed 27 potential confounding factors with $p<0.25$. (Table 3)

After accounting for these potential confounders, intubation by EP is not found to be associated with increased 30 days mortality (Adjusted OR 1.253, $p=0.607$).

Other Analyses

Sensitivity Analysis

We performed a sensitivity analysis of the missing data by assuming missing completely at random. Missing data were then deleted listwise. 316 cases remained for re-analysis.

This does not differ from the main result significantly in both the primary and secondary outcomes.

Logistic regression analysis

A stepwise logistic regression analysis was done on the cohort to identify independent predictors of outcome. (Table 3)

Discussion

Key Results

This retrospective cohort study demonstrated that higher 30-day all-cause mortality occurred in the group of patients who were intubated by EP. However, the mortality difference is not substantiated by those secondary outcomes and complications. Both groups had 100% rate of successful intubation. Respiratory and airway complications such as VAP and HAP did not have any statistical significant difference. The immediate post-intubation complications such as cardiac arrest, hypotension and hypoxia did not differ in both groups.

The more probable explanations for the primary outcome difference of the two groups are the baseline imbalance leading to those confounding factors. 27 potential confounding factors ($p < 0.25$) are detected (Table 3). As a matter of fact, those baseline parameters do expose some logical explanation for the observed primary outcome difference. EP group patients were older (65.5 vs 58 years old), suffered from more (77.1% vs 66.3%) and severer (pre-intubation GCS 5.5 Vs 8) head injury and poorer initial physiological status (RTS 5.9342 vs 5.4967). All of these parameters are statistically significant.

On the other hand, the lower pre-intubation SBP (141.16 vs 156.47 mmHg) and first recorded SpO₂ (99% vs 100%) in the AN group are clinically not significant despite significant statistically. There were more bleeding patients in the AN group. Chest trauma (41% vs 20.8%), use of massive transfusion protocol (23.9% vs 13.2%), three-in-one procedures for pelvic fracture (16.1% vs 6.9%) and laparotomy rate (9.3% vs 3.5%) are significantly more than the EP group. Given a comparative percentages of patients with ISS ≥ 15 in both groups (80.5% vs 84.7%), EP group with more and severer head injury patients explains the higher 30-day all-cause mortality [16].

Limitations

The current study is a single centre retrospective cohort study. Clinical practice varies from different trauma centres, case loads, service scale and staff expertise. The availability of onsite anaesthesiologists is also variable among some EDs.

The decision of who perform intubation is one of the limitations of our study. The attending EP may have intubated patients on their own or consulted anesthesiologists to intubate, the rationale behind is on case-by-case basis.

Grade of laryngeal view and use of direct and video laryngoscopy are not well documented. Hence difficulty of intubation could not be compared. First pass success data are missing in most of the ED records, and experience of intubationists (and their supervisors if any) could not be tracked in our study. Therefore, we could not use first pass success as one of our outcomes.

When determining the independent predictors for mortality, the sample size may not be sufficient as we calculated our sample size based on crude primary outcome which is 30-day all-cause mortality.

As for the outcome measures, we did not measure the functional outcome, or examine the quality of life, both of which are important outcomes for survivors of severe trauma.

Interpretation

In this retrospective cohort study, it cannot demonstrate any difference in 30-day all-cause mortality for patients indicated for intubation as performed by EP or AN. All the secondary outcomes and immediate post-intubation complications are comparable. Suffice to say, in circumstances when emergency

intubation for trauma patients is required and AN is not immediately available, EP can intubate the patients safely.

Generalisability

Our study result is applicable to all urban EDs with a well established, emergency physician-lead trauma service.

Declarations

Funding

The authors did not receive any funding for the current study.

Ethical approval was sought from Research ethics committee, Kowloon Central Cluster, Hospital Authority of Hong Kong (KC/KE-18-0232/ER-3).", Patient consent was waived by the ethics committee.

The authors declare no competing interests.

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Tables

Tables 1-3, as cited in the manuscript, are not included in this submission.

Appendix

Appendix

(Trauma activation criteria of the centre. Version Jan2019)

The following Trauma Team Activation Criteria identify potential trauma patients and mandate the activation of the Trauma Team. These are based on specific anatomical injuries, physiological parameters, and mechanisms of injury that indicate actual instability or a patient at high risk. The criteria are designed for adult trauma patients. Appropriate modification should be applied to paediatric trauma victims.

- Criteria A or B1 are absolute indication to activate Trauma Team
- Criteria B2, C & E are relative indication to activate Trauma Team
- Criteria D is a factor to consider for those fulfilling criteria B2 or C

A. Physiological Derangement

1. Glasgow Coma Scale ≤ 13
2. Respiratory Rate < 10 or > 29 per minute
3. Systolic Blood Pressure < 90 mmHg

B. Type of Injury.

B1 Major

1. Extensive facial injury /burn with potential airway compromise
2. Flail chest
3. Spinal injury with neurological signs (e.g. limb paralysis)
4. 2 or more proximal long bone fractures
5. Traumatic amputation / crush injury of limb proximal to wrist or ankle
6. Major pelvic fracture
7. Penetrating injuries to head, neck, chest, abdomen and extremities proximal to elbow or knee
8. Burn $>20\%$ body surface area (BSA) for adults and 10% BSA for children

B2 Others

1. Blunt or crush injury to chest or abdomen
2. Burn $10-20\%$ BSA for adult patients and $5-10\%$ BSA for children

C. Mechanism of Injury.

1. Severe traffic accident, e.g.
 - ejection of patient from vehicle
 - major car deformity (>18 inches at any site, side intrusion into passenger compartment > 12 inches)
 - death of an occupant in the same vehicle
2. Motorcycle crash > 30 Km/h
3. Pedestrian hit or run over by vehicle or with significant impact (>30 Km/h)
4. Adult: Fall > 20 feet or 6 meters(usually 2nd floor)

Children: Fall >10 feet or 2-3 times the height of the child

D.Age or concurrent illness

1. Young (<5 yr old) or old (>65 yr old)
2. Major medical disease e.g. cardio-pulmonary disease, renal failure, coagulopathy (e.g. drug related such as anti-coagulants, anti-platelets etc; other medical conditions such as cirrhosis, hemophilia etc.)
3. Pregnancy >20 weeks

E.Inter-hospital transfer

Patients with traumatic injuries transferred from other hospitals for further management.