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Prehospital Tracheal Intubation versus Emergency Department Intubation for Trauma Patients

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ABSTRACT

Background: Patients with severe traumatic brain injury (TBI) are at high risk for airway obstruction and hypoxia at the accident scene, and routine prehospital endotracheal intubation has been widely advocated.

Aim of the Study: to evaluate and compare the outcome and mortality rates of trauma patients undergoing Prehospital Tracheal Intubationversus those undergoing Emergency Department Intubation.

Methods: A literature search was carried out on MEDLINE (including MEDLINE in-process), CINAHL, Embase and the Cochrane Library (from 1990 to October 2017). Databases using “Prehospital Tracheal Intubation”, “Emergency Department Intubation “, “Adults’ trauma”, and “mortality” as a MeSH heading and as text word. High yield journals were also had searched.

Results: Eleven studies enrolling 17317 patients were included, out of which 4545 underwent PTI while 12772 underwent EDI. Median mortality rate in patients undergoing pre-hospital intubation was 52.12% (7.8–90.16%), compared to 27.98% (6.25–41.56%) in patients undergoing intubation in the emergency department. The overall quality of evidence was very low. Six of the eleven studies found a significantly higher mortality rate after pre-hospital intubation whilst five found no significant differences.

Conclusion: Study outcome suggests that EDI was superior to PHI. Nevertheless, prehospital intubation was a marker for more severely ill patients who would have had higher mortality thus, the **suggestion of the association between pre-hospital intubation and a higher mortality rate does not essentially oppose the importance of the intervention, but rather a need for further** investigation of the possible causes for this finding.

Keywords: Prehospital Tracheal Intubation, Emergency medical services, Airway management, Rapid sequence induction, mortality, Emergency Department, Intubation, Trauma.

INTRODUCTION

Airway compromise is declared to be a cause of poor outcomes and mortality in trauma and cardiac arrest patients for many years [(1)].

While physician-staffed ambulance services had been established worldwide for more than a century, the late 20th century evolution of prehospital care was highlighted by documentation of life-saving outcomes in those first modern EMS programs and their use of invasive ‘advanced life support’ (ALS) procedures including prehospital endotracheal intubation (ETI) and intravascular (IV) cannulation for drug administration [(2)]. These life-saving reports helped to propel the widespread adoption of EMS systems and the concomitant introduction of specially-trained (non-physician) emergency medical technicians called ‘paramedics’ [(2)]. Eventually nursing personnel also ventured into the realm of on-scene emergency response, particularly in the arena of air medical services.

After arriving into a hospital, the critical and complex intervention of emergency tracheal intubation (ETI) is usually provided by appropriately trained physicians. Most of these physicians are trained anaesthesiologists or emergency physicians trained in anaesthesiology[(3)].

Tracheal intubation (TI) is a critical intervention regularly conducted by emergency medical service (EMS) providers to secure the airway of severely ill or injured patients worldwide. This activity is based on th assumption that, in keeping with in-hospital practice, a compromised airway should be secured as early as possible to ensure adequate ventilation and oxygenation. However, because pre-hospital

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environmental and infrastructural factors can be challenging, intubation success rates are variable [4]. When TI is performed incorrectly, it can provoke adverse events and may worsen outcome in some patient groups [5]. Even when performed correctly, suboptimal ventilation following TI may increase the risk of fatal outcomes in certain patient subgroups [6].

The skill of ETI had become the definitive airway control for most critically ill and injured patients, being in the operating room, in the early phases of an intensive care unit (ICU) hospitalization, or in the out-of-hospital setting [7]. The presumed presence of significant physiological derangements (e.g., hypoxemia, hypercarbia, hypoperfusion) in cardiopulmonary arrest, head injury and hemorrhagic states made ETI an intuitive procedure to perform as soon as feasible in the critically ill and injured [7].

On the other hand, some trauma patients have an undiagnosed cervical spine injury, but require immediate airway control on arrival at the emergency department (ED). Intubation could potentially exacerbate the cervical spine injury, thus resulting in a worse neurological outcome.

The reported incidence of cervical spine injury in the setting of major trauma is 1.5%–4% [8]. This rises to 7.8% in patients with a Glasgow coma scale (GCS) of less than 8 **[9].** It has been postulated that 3%–25% of patients with cervical spine injury may suffer injury extension as a consequence of delays in diagnosis, or inappropriate handling of their injury**[10].**

Moreover, For patients not in cardiac arrest, emergency department intubation (EDI) is normally performed as rapid sequence induction intubation (RSI), which includes the use of a rapid-onset neuromuscular blocking agent before TI, whereas PHI is done both with and without drugs **[11].**

Although several guidelines suggest that TI should be considered for all trauma patients with a Glasgow coma scale (GCS) score of 8 or below, the evidence supporting the use of a particular GCS score as a threshold for intubation is poor **[12].**

This systematic review was performed to compare the outcome and mortality rates of adult trauma patients undergoing PHI versus those undergoing EDI.

MATERIALS AND METHODS

This review followed the PRISMA[13]. (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines, systematically identifying and appraising peer-reviewed RCTs reporting on the outcome and mortality rates of adult trauma patients undergoing PHI versus those undergoing EDI.

• We carried out a retrospective study on patients suffering from Trauma whom underwent PHI and EDI from 1990 to October 2017.

Data Sources

Literature searches of from MEDLINE (1990–2017), EMBASE (1990– 2017), Cochrane Library, CINAHL (1990–2017), Google Scholar, and individual ER journals. The search terms were used in combinations and together with the Boolean operators. 8 articles matched the stipulated criteria were included in the current review.

Search terms

Keywords, phrases, and MeSH terms searched included "pre-hospital", "intubation", "airway management "Emergency Department" and "PHI". Authors independently reviewed titles and abstracts and then downloaded relevant studies. References were reviewed for additional studies.

Study Selection and Criteria

Search results were screened by scanning abstracts for the following:

Inclusion Criteria

1- Publications in Arabic or English languages.
2- Relevantly recent studies (publications between 2005 and 2017).
3- Articles comparing the mortality rates of adult trauma patients who received PHI to those treated with basic airway management and subsequent EDI were considered.

Exclusion Criteria

1- Publications conducted in languages other than English and Arabic languages.
2- Articles that didn't meet the present study endpoint (i.e. did not specify PHI or EDI for all patients, different intervention technique and target study group).
3- Review articles, conferences and meeting abstracts
4- Patients with medical conditions, including cardiac arrest
5- Studies with poor quality.

Data Extraction

Two reviewers independently reviewed the studies, the abstracted data, and resolved disagreements by consensus. Studies were evaluated for quality. A review protocol was followed throughout:

Assessment of the quality and risk of bias of the study

Cochrane principles were applied as well as the Grading of recommendations assessment, development, and evaluation (GRADE) approach, risk of bias in randomized trials was assessed as high, low or unclear for allocation concealment, blinding, incomplete outcome data, selective reporting and other limitations [14].

All RCTs (Randomized trials) were considered by the GRADE approach to provide high-quality evidence in the absence of important limitations. As for observational studies, an assessment table was developed based on the principles stated by the MOOSE group and the National Institutes of Health [15].

Every observational study was examined for exact details and information of the study population, clear statement of the outcomes measures and outcome assessment for both of the patient groups, directly comparable patient groups, consistent results, credentials of important confounders and prognostic factors and the absence of serious methodological limitations. The methodological quality of the individual observational studies was rated as good, fair or poor. In the GRADE approach, observational trials without special strengths or important limitations were considered to provide low-quality evidence and hence excluded from the studies of consideration.

The study was done after approval of ethical board of Imam Abdulrahman Bin Faisal university.

RESULTS

Searches identified 732 publications in addition to another 11 publications that were found through manual research. After removal of duplicates, abstracts, titles of 443 publications were assessed as identified from title and abstract, and 364 papers were excluded. In a second round of screening for eligibility, further 71 were excluded since 19 papers full text could not be retrieved and another 12 papers with the same cohort. There were also 32 papers excluded because they did not match the study outcome. We followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) [17] guidelines in reporting the results. Figure 1

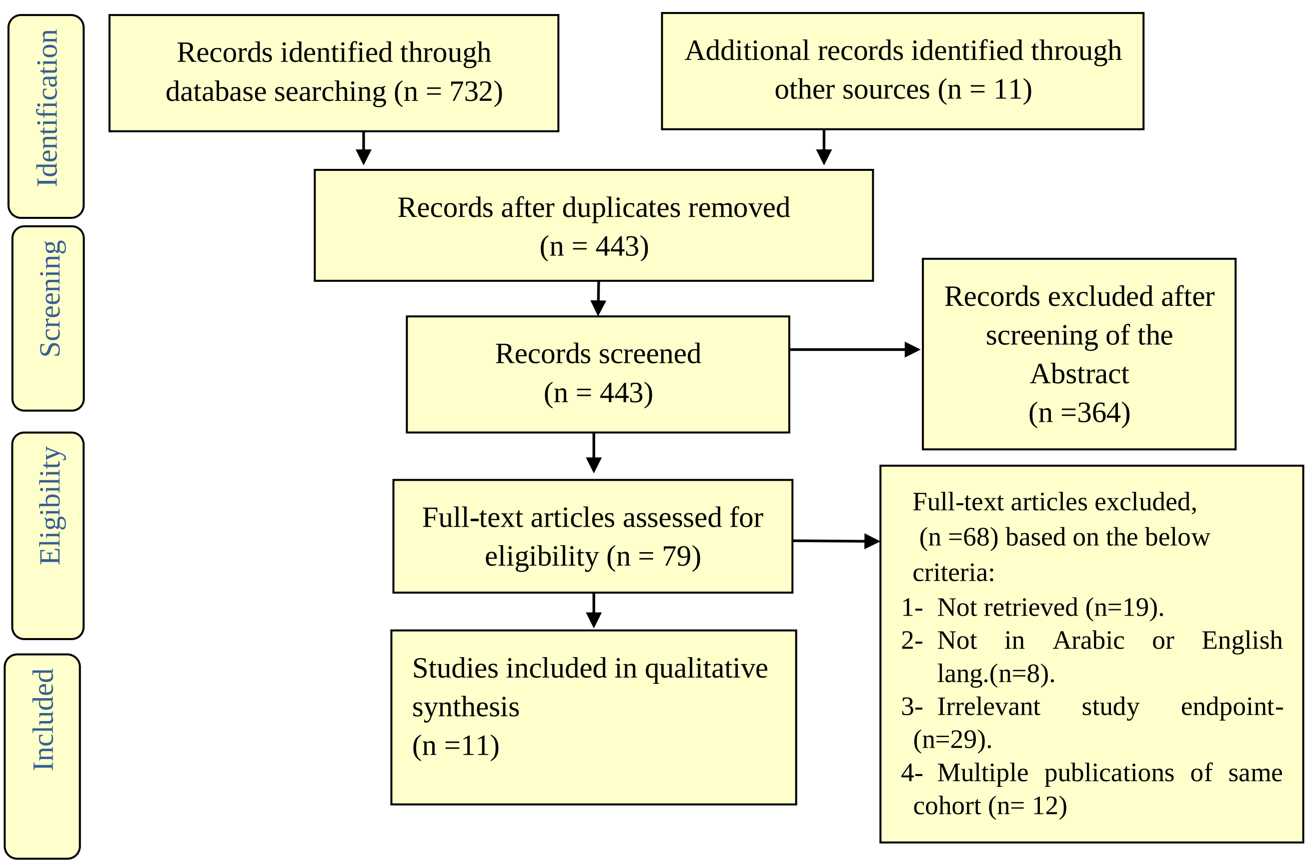

Figure 1: PRISMA flow diagram showing the selected criteria of assessed the studies [13].

Finally,11 studies were included and detailed as the focus for the present study.
The search yielded 11 publications enrolling 17317 participants in 6 countries (Qatar, Canada, USA, Norway, Netherland and Australia), 8 out of which were Retrospective database studies (RDB's), one RCT , one Retrospective review of medical records and one Prospective cohort study. Publication dates ranged between 2006 and 2014 while study duration had a range from 1 to 9 years. injury severity score and Rapid sequence induction data were also reported.
Table 1 shows a detailed overview of the included studies.

Table 1: baseline characteristics of the studies included in the systematic review

Authors	Year of Study closeout	Duration of Study (years)	Country	Study Type	No. of participants	Diagnosis of participants	Patients treated by physicians	ISS similarity	RSI
Tracy et al. [16]	2006	1	USA	RDB	628	Trauma	No	No	NA
Bernard et al. [17]	2010	4	Australia	RCT	312	TBI	No	Yes	Yes
Sollid et al. [18]	2010	9	Norway	Retrospective review of medical records	287	Trauma	Yes, anaesthesiologists	No	Yes
Evans et al. [19]	2010	1	USA	RDB	572	Trauma	No	Yes	Yes
Irvin et al. [20]	2010	5	USA	RDB	10948	TBI (trauma + GCS 3)	No	No	No
Franschman et al. [21]	2011	4	the Netherlands	RDB	336	TBI	No	No	No, only for some patients
Bukur et al. [22]	2011	4	USA	RDB	2366	TBI	No	No	No
Vandromme et al. [23]	2011	3	USA	Prospective cohort study	149	TBI	No	No	No, only for some patients
Evans et al. [24]	2013	9	Canada	RDB	1027	TBI (trauma + GCS <9)	No	No	No
Tuma et al. [25]	2014	3	Qatar	RDB	210	TBI (head AIS ≥3 and GCS <9)	No	Yes	Yes
Al-Thani et al. [26]	2014	1	Qatar	RDB	482	Trauma	No	No	Yes

NA: Not available, ISS injury severity score, RSI Rapid sequence induction, ED emergency department, TBI Traumatic brain injury, GCS Glasgow coma scale, DOA dead on arrival, CPR cardiopulmonary resuscitation, CT computed tomography AIS abbreviated injury scale, ETI endotracheal intubation.

Majority of the studies included information on the clinical parameters associated with injury severity and used some form of correction before drawing a conclusion about the effect. Table 2

Table 2: Outcome of the studies included in the systematic review

Authors	Type of mortality measure	Exclusion of patients dying in the pre-hospital or ED phase	Mortality PHI (%)	Mortality EDI (%)	ISS PHI	ISS EDI	GCS PHI	GCS EDI	Shock/average SBP PHI (%)	Shock/average SBP EDI (%)
Tracy et al. [(16)]	Not specified	Yes, up to 48 hours	32%	28%	25.3	22.4	4	8.3		
Bernard et al. [(17)]	In-hospital	No	36%	36%	30.5	30.1	5	5	128	129
Sollid et al. [(18)]	In-hospital	No	45%	21%			3	6		
Evans et al. [(19)]	In-hospital	Death or discharge within 48 hours excluded	8%	6%	27.2	27	4.1	11.6	122,4	125,5
Irvin et al. [(20)]	In-hospital	Only patients with circulation at hospital admission included	62%	35%	31.6	24.2	3	3	121,3	130,1
Franschman et al. [(21)]	In-hospital	Not specified, but only patients with a CT-confirmed TBI included.	43%	41%	32	25	3	5	23	11
Bukur et al. [(22)]	Not specified	DOA, in the pre-hospital environment, died in the ED, or any AIS = 6 excluded	90%	12%	26.7	18.4	3.3	11.7	73.8	4.5
Vandromme et al. [(23)]	Not specified	Not specified, but only patients with a CT-confirmed TBI included	47%	41%	38	33.7	4.1	5.9	avg 127,4	151,3
Evans et al. [(24)]	In-hospital	Patients that received pre- or in-hospital CPR excluded from mortality analysis	68%	42%	31	26	3	6	28.8	15.3
Tuma et al. [(25)]	30 days	Yes, up to 24 hours	54%	16%	28	27			avg 129	142
Al-Thani et al. [(26)]	Not specified	Patients who died on scene before ETI excluded	53%	19%	25.3	21.3	6.9	12.1	avg 127.9	. 129.4

PHI pre-hospital intubation, EDI emergency department intubation, ISS injury severity score, GCS Glasgow coma scale, SBP systolic blood pressure, avg average, AOR adjusted odds ratio, ED emergency department, RR risk ratio , AIS abbreviated injury scale

Further to the analysis of the outcome and authors' conclusion of the 11 studies included, Six concluded that PHI was associated with a worse outcome than EDI whilst four found no differences in mortality between the groups, however, one found a PHI had insignificant impact on mortality, but improved neurological outcome.

Table 3: Author's conclusion and quality of the studies determined by the assessment tool

Authors	Conclusion of article	Methodological quality
Tracy et al. *[16]*	No significant differences in outcomes between groups	Fair
Bernard et al. *[17]*	PHI had no significant impact on mortality, but improved neurological outcome	Good
Sollid et al. *[18]*	PHI associated with worse outcome	Fair
Evans et al. *[19]*	No significant differences in outcomes between groups	Fair
Irvin et al. *[20]*	PHI associated with worse outcome	Fair
Franschman et al. *[21]*	No significant differences in outcomes between groups	Fair
Bukur et al. *[22]*	PHI associated with worse outcome	Fair
Vandromme et al. *[23]*	No significant differences in outcomes between groups	Fair
Evans et al. *[24]*	PHI associated with worse outcome	Fair
Tuma et al. *[25]*	PHI associated with worse outcome	Fair
Al-Thani et al. *[26]*	PHI associated with worse outcome	Fair

DISCUSSION

The priority in the emergency care of trauma patients is the assertion of a clear airway to guarantee adequate oxygenation and ventilation. The ABCs of trauma resuscitation begin with the airway evaluation, and effective airway management is imperative in the care of a patient with critical injury[27].

Hussain and Redmond[28]concluded, in their study examining pre-hospital deaths from trauma in the UK, that up to 85% of patients who died with survivable injuries before reaching hospital might be due to airway obstruction and showed that airway obstruction was thought to have contributed to death from major trauma in 28% of patients treated by ambulance crews. **Karch and his colleagues[29]** noted in their study of field intubation in trauma patients that, in nearly a quarter of the patients, intubation failure was most likely from gagging or combative patients. Definitive airway control by pre-hospital ETI is, therefore, not only essential, but also difficult to perform.

In the present study, we aimed at evaluating and comparing the outcome of pre-hospital tracheal intubation to emergency department intubation in trauma patients.

It was clear that no single study identified a positive effect on the mortality rate when PHI was compared to EDI.

Eleven separate analyses of the eligible publications were made;of these found a significantly higher mortality rate in the PHI-patients; crude mortality rate in both RSI (five trials) and non RSI (six investigations) .

RSI is the preferred method of endotracheal tube intubation (ETTI) in the emergency department (ED). This is because it results in rapid unconsciousness (induction) and neuromuscular blockade (paralysis). This is important in patients who have not fasted due to greater risk for vomiting and aspiration. To this end, the goal of RSI is to intubate the trachea without having to use bag-valve-mask (BVM) ventilation, which is often necessary when attempting to achieve intubating conditions with sedative agents alone (eg, ketamine, etomidate, propofol) [30].

The findings of our study are supported by a systematic review conducted by **Fevang*et al.*[31]**which enrolled 21 studies looking at prehospital vs emergency department intubation of trauma patients. They found that the pooled mortality rate for patients intubated prehospital was 48% as opposed to 29% in the ED. The overall conclusion of the present study, was that the , quality of the studies was low.

It is doubtful that any pre-hospital services will achieve the level of care and equipment provided by a full in-hospital trauma team, which means that the motivation for PHI is that early protection and control of the airway outweighs the increased risks associated with performing the procedure in a less preferable setting. Irrespective to the weaknesses concerning low-quality evidence, the consistent finding of worse outcomes after PHI compared with EDI should raise some inquiries .Variable effects in subgroups of patients have led to recommendations for a tailored approach to interventions in other fields of emergency care, and this may also be valid for pre-hospital airway management [32].

CONCLUSION

Pre-hospital intubation is a complex intervention where guidelines and research findings should be approached cautiously. Our findings in the present paper suggest that higher mortality rates were associated to PHI over EDI. Nevertheless, The association between PHI and a higher mortality rate does not necessarily contradict the importance of the intervention, but it does call for a thorough investigation by clinicians and researchers to find out possible causes for this finding.

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