Review of Global Medicine and Healthcare Research

www.iomeworld.com/rgmhr/

ISSN: 1986-5872

Volume 5 No. 1 (2014)
Potential Risks and Benefits of Prehospital Intubation in Patients with Severe Head Trauma

Mihails Dolgusevs 1*, Natalija Berza 1, Olegs Sabelnikovs 2

1 Riga Stradins University, Dzirciema Street 16, Riga, Latvia
2 Department of Anaesthesiology and Intensive Care of Riga Stradins University, 13 Pilsonu Street, Riga, Latvia

* Corresponding Author: Mihails Dolgusevs
Address: Bikernieku street 160/9 – 24i, Riga, LV-1079, Latvia
Email: dolgusevs@gmail.com

Abstract

Background: Generally, it is recommended to do an early endotracheal intubation for head-trauma patients who have Glasgow Coma Scale (GCS) score no more than 8. It gives possibility to avoid potential hypoxia and aspiration. Nevertheless, it is still unclear and discussible how useful is prehospital intubation for patients with head trauma.

Aim: to evaluate potential risks and benefits of using prehospital intubation in patients with severe head-trauma.

Methods: A retrospective study during the period from January 2012 till the end of May 2013. The study included information about 93 patients who were treated in the Riga Eastern University hospital and brought there by the Emergency Medical Service of the Riga Regional Ambulance Center. Patient inclusion criteria were the following:

- primary diagnosis is set as brain trauma (selected patient history IDC - 10 codes: S061 - S068, S070 - S079) with evaluation of no more than 8 according to Glasgow coma scale (GCS) in the hospital emergency department;
- arterial blood gas analysis done within an hour from the moment of admission in the hospital.

Patients with other types of injuries and serious or chronic illness, which may directly affect the recovery prognosis or mortality, were excluded from the study. The data was processed with SPSS v20 (Statistical Package for the Social Sciences) software.

Results: During the analysis, it was observed that patients with prehospital intubation had more frequent aspiration (57.1% versus 7.7%, p=0.004). Additionally, analysis showed that there are neither statistically significant differences in arterial blood gas (P\textsubscript{a}CO\textsubscript{2}, P\textsubscript{a}O\textsubscript{2}) test results to indicate potential hypoxia (GCS<6 P\textsubscript{a}O\textsubscript{2} 154.9±85 mmHg / 171±54.4 mmHg (p=0.56) and P\textsubscript{a}CO\textsubscript{2} 44.1±9.4 mmHg / 42±7.2 mmHg (p=0.95), GCS≥6 P\textsubscript{a}O\textsubscript{2} 176.9±127.2 mmHg / 154.9±92.5
mmHg (p=0,72) and $P_aCO_2$ 42.9±5.9 mmHg / 39.6±6.9 mmHg (p=0,72), nor in mortality rates for patients who received prehospital intubation compared to patients who did not receive it (GCS<6 57.1% / 69.2% p=0.48, GCS≥6 18.2% / 46% p=0.09).

**Conclusion:** The results of analysis conclude that severe head-trauma patient’s health status, mortality and recovery forecasts by choosing alternative ways to ensure respiratory functions in prehospital, are not worse than in cases of early performed endotracheal intubation.

**Key words:** prehospital intubation, head trauma, brain injury.

**Introduction**

Head brain trauma is the main cause of death and disability under the age of 40 and also the main cause for losing years of quality life.\(^1\) In the period between 1998 and 2004, there were 415 to 460 head brain trauma cases on each 100 000 people.\(^2\)

After getting head trauma, there is a primary injury that is caused by impact of traumatizing force. It is not possible to assess the level of the anatomic damage before hospitalizing. This is the sphere of neurosurgeries’. After a traumatizing force impact, a secondary damage starts as a result of cytotoxic processes, electrolyte imbalance, mitochondrial dysfunction, secondary ischemia, hypoxia, intracranial pressure increase and brain dislocation and inflammation.\(^9\)\(^-\)\(^13\) It is possible to influence these processes before patient is brought to a hospital and significantly reduce and delay their development. This is the main task of emergency medical services to perform before hospitalization.

There are different methods of head trauma classification. In this thesis, to select patients with severe head injuries classification based on the patient's level of consciousness was chosen. It represents a point system according to one of the scales, the most common of the Glasgow coma scale (GCS). This classification is widely used across the Europe, including in Latvia. It is assumed that 13 to 15 points per GCS corresponds to mild head trauma, 9 to 12 points corresponds to moderate head trauma and 8 points or less corresponds to severe head trauma.\(^4\)

In case of severe head injury, it is important to start treatment on the way to hospital under existing guidelines. The main goal of Emergency Medical Service is to prevent hypoxia, hypovolemia and hypotension.\(^5\) Generally, it is recommended to do an early endotracheal intubation for head-trauma patients who have Glasgow Coma Scale (GCS) score no more than 8. It gives possibility to avoid potential hypoxia and aspiration.\(^6\) Nevertheless, it is still unclear and discussible how useful is prehospital intubation for such patients. The world has taken a lot of research on this topic, but no such research was done in Latvia so far.
As an example, one study in Australia included 312 patients with severe brain injuries. It showed that early prehospital intubation made by paramedics was associated with better recovery prognosis for the six-month interval compared to patients who were intubated after arrival to the hospital. On the other hand, another study in the U.S. concluded that the prehospital endotracheal intubation associated with increased mortality, presumably due to excessive hyperventilation during transport, transient hypoxia due to longer run-time prior to transport to the hospital.

The goal of this thesis is to evaluate potential risks and benefits of using prehospital intubation for patients with severe head-trauma. Additionally, the thesis should conclude whether heavy head-trauma patients’ who have Glasgow Coma Scale (GCS) score no more than 8, health status, mortality and recovery forecasts by choosing alternative ways to ensure respiratory functions in prehospital, are not worse than in cases of early performed endotracheal intubation.

**Methods**

As a key method of the thesis was selected a retrospective study, that covers the period between January 2012 and the end of May 2013. The study included 93 patients who were treated in the Riga Eastern University hospital and brought there by the Emergency Medical Service (EMC) of the Riga regional ambulance center.

Patient inclusion criteria were the following:

- primary diagnosis is set as brain trauma (selected patient history IDC - 10 codes: S061 - S068, S070 - S079) with evaluation of no more than 8 according to Glasgow coma scale (GCS) in the hospital emergency department;

- arterial blood gas analysis done within an hour from the moment of admission in the hospital.

Patients with other types of injuries and serious or chronic illness, which may directly affect the recovery prognosis or mortality, were excluded from the study.

In the first stage of the study, patient data was collected from Riga Eastern University hospital archive, including patient demographic data (age, gender), GCS assessment of hospital’s admissions department, duration of hospitalization, mortality, aspiration fact, intubation fact in the Emergency department, and arterial blood gas values.

In the second stage of study, selected patient data from Riga Eastern University hospital also was collected from the Emergency Medical Service of the Riga regional ambulance center archive, including call completion time, GCS assessment of the patient prehospital and at arriving in the hospital, prehospital intubation, failed intubation fact, premedication, and induction medication use at prehospital intubation.
Patients were divided into two groups - prehospital intubated (PHI) and prehospital non-intubated (PHNI) and each of the groups were divided into two subgroups - patients after GCS assessment under 6 points and GCS with more than 6 points. The obtained data were statistically analyzed and compared.

The data was processed in SPSS v20 (Statistical Package for the Social Sciences) software. In the study two independent samples were compared. Quantitative data was analyzed using t-test for independent samples or Mann-Whitney test, depending on the relevance distribution per Kolmogorov-Smirnov test. The qualitative data was analyzed using in the chi-square test.

The survival time was analyzed by applying Coke regression, Kaplan-Meier method and Logrank test. The survival median was analyzed and survival curves were designed concerning age groups.

Results

The study included 93 patients - 77 (82.8 %) men and 16 (17.2%) women in age from 15 to 89 years. There were 10 (10.8 %) patients in age over 65 years. 45 (48.4 %) of patients included in the study died in the hospital, four of them (8.9%) on the first day of hospitalization.

Detailed information about patients is displayed in Table 1. 32 patients were prehospital endotracheal intubated, 61 patients were intubated in hospital emergency department. In a statistical analysis using the "t" - test between groups PHI and PHNI statistically differed case completion time (p = 0.002). Group differences were found between GCS average valuations prehospital: PHI Group - 5.0 points, but PHNI group - 7.8.

The comparison of drugs used in PHI is illustrated in Figure 1. Prehospital intubation in all cases was used with one of the sedation medication, most commonly S. Diazepam 10 mg i/v. In the most of intubation cases analgesic drug also was used, commonly S. Phentanyli 0.1 mg i/v. The least likely in prehospital intubation was used muscle relaxant. Mostly in all cases when a muscle relaxant was used it was S. Lysthenoni 100 mg i/v.

An analysis of data using the Kolmogorov - Smirnov test found that the severe head injured patients with GKS <6 length of stay is statistically different, depending on the prehospital intubation fact - PHI spent in the hospital longer than PHNI (p < 0.05). The overall mortality was higher among patients PHNI (see Table 2), but the data did not reflect on a statistically significant difference (the GCS <6 p = 0.48, GCS ≥ 6 p = 0.09). PHI patients more likely were diagnosed with aspiration and PHI patients with GKS < 6 to 57.1 % versus 7.7 % (p = 0.004), while a subset of the GKS ≥ 6 did not generate a statistical significant difference (p = 0.09) - 36 4% (PHI group) to PHNI group, 14.6 % (PHNI group) (see Figure 2).
Arterial blood gas pH and lactate (cLac) statistical analysis in both groups and subgroups of patients did not differ statistically significant (the GKS < 6 p = 0.57 and p = 0.96, GKS ≥ 6 p = 0.88 and p = 0.49) (see Table 3).

Also, arterial blood gas potential diagnostic indicator of hypoxia (P$_a$CO$_2$, P$_a$O$_2$) analysis by Kolmogorov - Smirnov test showed no statistically significant differences between subgroups of the groups (the GKS < 6 p = 0.95 and p = 0.56, GKS ≥ 6 p = 0.72 and p = 0.72) (see Figures 3, 4).

The analysis of possible diagnostic indicator of hypoxia (P$_a$CO$_2$, P$_a$O$_2$) was also made by Kolmogorov - Smirnov test, and the lowest value of GCS was considered as 4 instead of 6 in prehospitaly valued patients. However, the following sub - grouping between the groups (GCS = 3 / GCS ≥ 4) showed no statistically significant differences in oxygenation values (by GKS = 3 p = 0.91 and p = 0.93, GKS ≥ 4 p = 0.81 and p = 0.97).

As possible mortality influencing factors were selected the following: patient age, prehospital intubation, GCS prehospital rating. Mortality statistically significant was influenced only by patient's age (p = 0.008). Other data (prehospital intubation, GCS prehospital score) had no statistically significant difference (p = 0.35 and p = 0.07). Calculated median survival: ≤ 65 - 67 days > 65 - 7 days (see Figure 5). After Logrank test of survival between the two groups had statistically significantly difference (p = 0.007).

**Discussion**

Making a comparison in two groups – prehospitaly intubated/non-intubated, there was no significant statistical data received that prehospital intubation would benefit to patient’s health condition, prognosis or mortality. Therefore potential benefits/losses should be carefully considered making this manipulation. There was a similar conclusion also in other researches, for example, retrospective cohort research which was published in 2007, Oregon, USA; the results did not show decrease in mortality among prehospitaly intubated patients with GCS ≤ 8 scores.

Analyzing mortality among prehospitaly intubated/non-intubated patient groups, subgroups dividing by GCS, there was no statistically significant difference – accordingly GCS < 6 p = 0.48, GKS ≥ 6 p = 0.09. There was a try to find out other factors which could influence mortality; however the only factor which statistically influenced mortality was age (p = 0.008). Calculating survival median it is clear that day difference among age groups is considerable - ≤ 65 years – 67 days, > 65 years – 7 days.

Making arterial blood gas values hypoxemia (P$_a$CO$_2$, P$_a$O$_2$) analysis among groups in subgroups. In none of the cases statistically significant difference was found (respectively GCS < 6 p = 0.95 and p = 0.56, GCS ≥ 6 p = 0.72 and p = 0.72). On the basis of Denmark’s EMC experience to
intubate traumatized patients prehospitaly with GCS = 3, hypoxia values dividing in subgroups were compared GCS = 3 / GCS ≥ 4. However no statistically significant difference between groups (respectively GCS = 3 p = 0,91 and p = 0,93, GCS ≥ 4 p = 0,81 and p = 0,97). Similarly no statistically significant difference was found in pCO2, pO2 values in retrospective research done in Denmark in 2009.

Therefore none of the objective values showed that prehospital endotracheal intubation would be better than other free respiratory tract ensuring methods. Still, many drawbacks were found out which are caused by intubation and they can be also fatal to a patient.

One of the factors that can negatively influence the prognosis, is aspiration which was found more frequent in subgroups of prehospitaly intubated patients, respectively GCS < 6 – 57,1 % to 7,7 % (p = 0,004), GCS ≥ 6 – 36,4 % to 14,6 % (p = 0,09). One of the reasons of such results could be the absence of skill and practice in Emergency personnel making endotracheal intubation. Furthermore, if premedication is given, also sedation, gag reflex disappear and there is a greater risk to aspiration, if intubation is made for a long period of time, traumatically or oesophagus is intubated. Of course, there are number of patients that are aspirated before the arrival of emergency, but such patients are in both groups, therefore it should not significantly influence credibility of results. It did not succeed to specify the moment of aspiration, it can be a goal of further studies. Analysing the risks of aspiration of prehospitaly intubated/non-intubated traumatic patient groups similar results were received by a research published in 2003 in the USA, Boston. Aspiration was two times greater in group of intubated patients. (50% to 22%).

Furthermore, other very significant factor is time when help was provided to a traumatic patient. There was statistically significant difference between groups (prehospitaly intubated/non-intubated) comparing case completion time – respectively 45,3 ± 21,1 minutes and 32,2 ± 11,8 minutes (p = 0,002). Taking into account facts laid out above, the only difference which splits these calls in two groups is the fact of intubation, what medical team spend in average 13 minutes on. However, if there are no objective factors met which improve the health condition of intubated patients, is it worth to spend 13 minutes at the place of emergency call trying to intubate a patient? Maybe it is better for a patient’s health to get transported to specialized hospital as soon as possible?

**Conclusion**

The results of analysis conclude that severe head-trauma patient’s health status, mortality and recovery prognosis by choosing alternative ways to ensure respiratory functions in prehospital, are not worse than in cases of early performed endotracheal intubation.

It is concluded that in the group of prehospital intubated patients prehospital time prior to transportation to the hospital for the qualified assistance increases significantly. There is greater presence of aspiration among prehospital intubated patients.
There were no statistically significant differences in arterial blood gas potential hypoxia parameters ($P_aCO_2$, $P_aO_2$), as well as mortality rates among groups - prehospital intubated / non-intubated. The comparison was performed in the subgroups divided by GCS: GCS<6/GCS≥6 and GCS=3/GCS≥4.

Patient’s age was identified as a statistically significant factor that influences mortality rate. On the other hand, GCS and prehospital endotracheal intubation fact does not have statistically significant effect on mortality.

Conflict of Interest: None declared.

References


**Table 1:** Data analysis between groups – prehospital intubated / prehospital non-intubated patients

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Prehospital intubated N=32</th>
<th>Prehospital non-intubated N=61</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case completion time (average ± SD) (minutes) (p=0,002)</td>
<td>45,3 ± 21,1</td>
<td>32,2 ± 11,8</td>
</tr>
<tr>
<td>Died in the first day</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>GCS prehospital (points)</td>
<td>5,0</td>
<td>7,8</td>
</tr>
<tr>
<td>GCS admission department (points)</td>
<td>3,8</td>
<td>5,4</td>
</tr>
</tbody>
</table>

**Table 2:** Data analysis between groups – prehospital intubated / prehospital non-intubated patients

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Prehospital intubated N=32</th>
<th>Prehospital non-intubated N=61</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of hospitalization (± SD) (days)</td>
<td>33,9±52,7</td>
<td>19,9±7</td>
</tr>
<tr>
<td>Mortality (GCS &lt; 6 p = 0.48; GCS ≥ 6 p = 0.09)</td>
<td>57,10%</td>
<td>18,20%</td>
</tr>
</tbody>
</table>
Table 3: Comparison of arterial blood gas analysis

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Prehospital intubated</th>
<th>Prehospital non-intubated</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>N=32</td>
<td>N=61</td>
</tr>
<tr>
<td></td>
<td>GKS &lt; 6</td>
<td>GKS ≥ 6</td>
</tr>
<tr>
<td></td>
<td>GKS &lt; 6</td>
<td>GKS ≥ 6</td>
</tr>
<tr>
<td>pH (±SD) (GCS &lt; 6 p=0,57; GCS ≥ 6 p=0,88)</td>
<td>7,3±0,1</td>
<td>7,35±0,06</td>
</tr>
<tr>
<td></td>
<td>7,33±0,09</td>
<td>7,37±0,1</td>
</tr>
<tr>
<td>PₐCO₂ (±SD) (arterial blood sample) (mmHg) (GCS &lt; 6 p=0,95; GCS ≥ 6 p=0,72)</td>
<td>44,1±9,4</td>
<td>42,9±5,9</td>
</tr>
<tr>
<td></td>
<td>42±7,2</td>
<td>39,6±6,9</td>
</tr>
<tr>
<td>PₐO₂ (±SD) (arterial blood sample) (mmHg) (GCS &lt; 6 p=0,56; GCS ≥ 6 p=0,72)</td>
<td>154,9±85</td>
<td>176,9±127,2</td>
</tr>
<tr>
<td></td>
<td>171±54,4</td>
<td>154,9±92,5</td>
</tr>
<tr>
<td>cLac (±SD) (arterial blood sample) (mmol/L) (GCS &lt; 6 p=0,96; GCS ≥ 6 p=0,49)</td>
<td>3,6±1,7</td>
<td>2±1,1</td>
</tr>
<tr>
<td></td>
<td>3,5±1,3</td>
<td>3,7±3,1</td>
</tr>
</tbody>
</table>

Figure 1: Comparison of drugs used in prehospital intubation
Figure 2: Comparison of aspiration risk
Figure 3: $P_{a}\text{CO}_2$, $P_{a}\text{O}_2$ statistical analysis between subgroup GCS≥6 of the groups - prehospital intubated / prehospital non-intubated patients
Figure 4: $P_aCO_2$, $P_aO_2$ statistical analysis between subgroup GCS<6 of the groups - prehospital intubated /prehospital non-intubated patient
Figure 5: Survival Function