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Identification of thoracic injuries by emergency medical services providers among trauma patients

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ABSTRACT

Introduction: Severe thoracic injuries are time sensitive and adequate triage to a facility with a high-level of trauma care is crucial. The emergency medical services (EMS) providers are required to identify patients with a severe thoracic injury to transport the patient to the right hospital. However, identifying these patients on-scene is difficult. The accuracy of prehospital assessment of potential thoracic injury by EMS providers of the ground ambulances is unknown. Therefore, the aim of this study is to evaluate the diagnostic accuracy of the assessment of the EMS provider in the identification of a thoracic injury and determine predictors of a severe thoracic injury.

Methods: In this multicentre cohort study, all trauma patients aged 16 and over, transported with a ground erence standard. Prehospital variables were analysed using logistic regression to explore prehospital ambulance to a trauma centre, were evaluated. The diagnostic value of EMS provider judgment was determined using the Abbreviated Injury Scale (AIS) of ≥ 1 in the thoracic region as ref predictors of a severe thoracic injury (AIS ≥ 3).

Results: In total 2766 patients were included, of whom 465 (16.8%) sustained a thoracic injury and 210 (7.6%) a severe thoracic injury. The EMS providers' judgment had a sensitivity of 54.8% and a specificity of 92.6% for the identification of a thoracic injury. Significant independent prehospital predictors were: age, oxygen saturation, Glasgow Coma Scale, fall > 2 m, and suspicion of inhalation trauma or a thoracic injury by the EMS provider.

Conclusion: EMS providers could identify little over half of the patients with a thoracic injury. A supplementary triage protocol to identify patients with a thoracic injury could improve prehospital triage of these patients. In this supplementary protocol, age, vital signs, and mechanism criteria could be included.

Introduction

Trauma and injuries remain a significant global concern and adequate recognition and treatment of these patients is essential [1]. Among severely injured patients, the thoracic body region is the second most commonly injured after an injury to the head [2–6]. Compared to injuries to other body regions, mortality is highest for thoracic injuries [7]. Severe thoracic injuries are time sensitive and adequate triage to a facility with a high-level of trauma care is crucial. In the United States, level I and II trauma centres are capable of providing total care for patients with a severe thoracic injury [8]. In other countries, such as the Netherlands, level I trauma centres are equipped to care for patients with a severe thoracic injury. [9,10]

Prehospital trauma triage protocols help EMS providers to identify severely injured patients. In the Netherlands, the National Protocol for Ambulance Services –based on the Field Triage Decision Scheme established by the American College of Surgeons

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Committee on Trauma (ACS-COT)– is used to identify severely injured patients. [11] This triage protocol (as other prehospital trauma triage protocols used worldwide) includes only two criteria to identify a severe thoracic injury: penetrating trauma to the thorax and a flail chest. Prehospital trauma triage protocols are limited to help EMS providers identify patients with a thoracic injury, so the EMS providers must rely on their own judgment and experience. Identifying patients with a severe thoracic injury is difficult, as the majority of severe thoracic injuries do not affect vital signs, such as respiratory rate [3,12]. Consequently, the undertriage rate among severely injured patients with a thoracic injury is high, one study reported an undertriage rate of 40% [4,6,12].

It has previously been shown that emergency physicians of the Helicopter EMS only recognized 45% of the patients with a severe thoracic injury. [13] However, this has not been analysed among EMS providers of the ground ambulances. Therefore, the aim of this study was to evaluate the diagnostic accuracy of the assessment of the EMS provider in the identification of a thoracic injury among trauma patients and determine prehospital predictors of a severe thoracic injury.

Materials and methods

Study design and setting

This was a multicentre cohort study of prospectively collected data from the ambulance services of *Central-Netherlands* from January 2015 to December 2016. In this region, one level I trauma centre (the University Medical Centre Utrecht) region is equipped to care for patients with severe thoracic injury and the region has nine level II or III trauma centres, all were included in this study. All trauma patients aged 16 and over, transported with highest priority (siren and lights) to a trauma centre in region *Central-Netherlands*, were included. The region covers 535 square miles and has 1.2 million residents. EMS providers use the National Protocol for Ambulance Services to identify severely injured patients (Fig. 1) [11].

Patients transported outside of the studied region were excluded. This study was judged by the Medical Ethical Committee of University Medical Centre Utrecht as not subject to the Medical Research Involving Human Subjects Act.

Data

Prehospital data were collected from the ambulance services' electronic records, these included: patient demographics, vital parameters, description of the trauma mechanism, and reports on physical examination on site, including the suspicion of thoracic injury by EMS providers. Hospital data were collected from the institutional trauma registry and electronic medical records. The Dutch National Trauma Database registered the receiving hospital, Abbreviated Injury Scale (AIS), and mortality for all patients admitted to a hospital. For patients discharged from the emergency department, data was extracted from the electronic patient documentation. The injuries were coded by trained data managers, using AIS 2005, update 2008.

Outcomes and definitions

To determine the diagnostic value of the identification of a thoracic injury by EMS providers, the prehospital assessment of a thoracic injury, as documented in the ambulance report was used. Thoracic injury, defined as an injury with AIS score of ≥ 1 in the thoracic region, diagnosed at the trauma centre, was used as reference standard. A suspected thoracic injury was an injury with AIS score of ≥ 1 in the thoracic region, diagnosed at the hospital, combined with a description of a thoracic injury in the ambulance reports. A thoracic injury with AIS score of ≥ 1 diagnosed at the hospital, but not described in the ambulance report was considered an unsuspected thoracic injury. Prehospital variables were analysed to explore potential prehospital predictors of a severe thoracic injury. A severe thoracic injury was defined as an injury with an AIS score of ≥ 3 in the thoracic region [21,22].

Missing data

Missing data were analysed and appeared to be missing at random. Multiple imputation was used to account for the missing

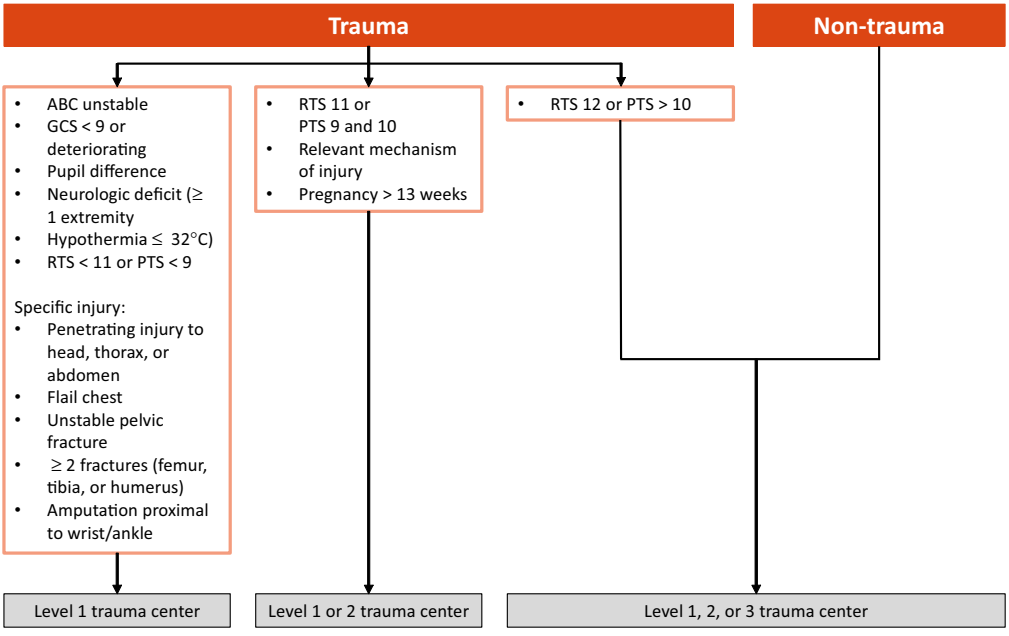

Fig. 1. The National field triage protocol of the Netherlands.

prehospital variables and was performed with SPSS v24 (IBM Corp, Chicago). Missing values were predicted based on all other predictors, as well as the outcome (AIS). The variables with missing data were: pulse (13.5%), respiratory rate (6.3%), systolic blood pressure (5.9%), diastolic blood pressure (6.1%), oxygen saturation (9.9%), and Glasgow Coma Scale (GCS, 6.5%). No patients missed the dependent variable; AIS.

Statistical analysis

Mean and standard deviation were used to describe continuous variables. Frequencies with percentages were used to describe nominal variables, ordinal variables. To compare baseline characteristics between patients with and without a (severe) thoracic injury, the Student *t*-test was performed for continuous variables. For nominal variables, the Chi-squared test was used, the Fisher's exact test was used for nominal variables that occurred in ≤ 5 cases. All tests were performed after multiple imputation and p-value < 0.05 was considered statistically significant. Frequencies and percentages were used to describe EMS provider judgment in the identification of a thoracic injury, stratified by AIS score. The diagnostic value of EMS provider judgment in the identification of a thoracic injury was determined using sensitivity and specificity. To determine potential prehospital predictors of a severe thoracic injury, univariable binary logistic regression was used. All predictors with a p-value < 0.05 were considered predictors of a severe thoracic injury and entered in multivariable analysis. All variables with a $p < 0.01$ were considered independent predictors. All statistical analyses were performed using SPSS v24 (IBM Corp, Chicago).

Table 1
Baseline characteristics.

Variables	All patients n = 2766	Thorax AIS ≥ 1 n = 465	Thorax AIS ≥ 1 not suspected n = 210	Thorax AIS ≥ 3 n = 170
Demographics	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Age (years)	49.0 (22.0)	52.1 (19.8)†	51.1 (21.1)	55.2 (20.2)•
	Number (%)	Number (%)	Number (%)	Number (%)
Male gender	1,605 (58.0)	306 (65.8)†	136 (64.8)	117 (68.8)•
Use of oral anticoagulants	132 (4.8)	18 (3.9)	10 (4.8)	6 (3.5)
Alcohol use	341 (12.3)	40 (8.6)†	27 (12.9)‡	19 (11.2)
Drug use	22 (0.8)	2 (0.4)	1 (0.5)	0 (0)
Vital signs*	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Systolic blood pressure	141 (26.2)	141.8 (27.5)	139.9 (28.6)	142.2 (29.8)
Diastolic blood pressure	85 (17.9)	86.4 (18.4)	83.8 (19.2)	86.4 (19.8)
Pulse	84 (21.2)	82.9 (23.0)	83.4 (23.2)	84.0 (22.5)
Respiratory rate	16 (4.2)	17.3 (5.2)†	16.3 (4.3)	18.1 (6.2)•
Oxygen saturation	97 (3.7)	96.0 (4.1)†	96.2 (3.9)‡	94.5 (4.8)•
Glasgow Coma Scale	14 (1.8)	14.0 (2.6)†	13.5 (2.9)‡	13.3 (3.4)•
Eyes	4 (0.6)	3.7 (0.7)†	3.6 (0.8)‡	3.5 (0.97)•
Motor	6 (0.7)	5.7 (0.9)†	5.6 (1.1)‡	5.5 (1.3)•
Verbal	5 (0.8)	4.6 (1.0)†	4.3 (1.2)‡	4.3 (1.3)•
	Number (%)	Number (%)	Number (%)	Number (%)
Systolic blood pressure < 90 mmHg	53 (1.9)	7 (1.5)	3 (1.4)	3 (1.8)
Respiratory rate < 10 or > 29 /min	65 (2.4)	27 (5.8)†	8 (3.8)	17(10.0)•
Mechanism of injury	Number (%)	Number (%)	Number (%)	Number (%)
Fall > 2 m	157 (5.7)	45 (9.7)†	25 (11.9)	20 (11.8)•
Fall 2-5 m	133 (84.7)	32 (71.1)†	18 (72.0)	12 (60.0)
Fall ≥ 5 m or ≥ 3x body length	24 (15.3)	13 (28.9)†	7 (28.0)	8 (40.0)•
Fall from stairs	243 (8.8)	48 (10.3)	25 (11.9)	21 (12.4)•
Fall from stairs, 1-10 steps	146 (60.1)	30 (62.5)	14 (56.0)	14 (66.7)
Fall from stairs, > 10 steps	97 (39.9)	18 (37.5)	11 (44.0)	7 (33.3)•
Motor vehicle accident > 65 km/h	154 (5.6)	43 (9.2)†	12 (5.7)‡	9 (5.3)
Motorcycle accident > 32 km/h	93 (3.4)	17 (3.7)	4 (1.9)	8 (4.7)
Car vs pedestrian impact > 10 km/h	47 (1.7)	12 (2.6)	7 (3.3)	7 (4.1)
Car vs bike impact > 10 km/h	156 (5.6)	30 (6.5)	19 (9.0)‡	15 (8.8)
Accident with e-bike	24 (0.9)	7 (1.5)	22 (10.3)	2 (1.2)•
Airbag deployment	135 (4.9/0	37 (8.0)†	13 (6.2)	8 (4.7)•
Injury characteristics	Number (%)	Number (%)	Number (%)	Number (%)
Penetrating injury to thorax	12 (0.4)	11 (2.4)†	0 (0)‡	4 (2.4)•
Flail chest	3 (0.1)	3 (0.6)†	0 (0)	3 (1.8)
Seatbelt sign	7 (0.3)	4 (0.9)†	0 (0)	3 (1.8)•
Complaint of thoracic pain	229 (8.3)	132 (28.4)†	1 (0.5)‡	44 (25.9)•
Burning wound or inhalation trauma	31 (1.1)	3 (0.6)	1 (0.5)	3 (1.8)
Suspicion of thoracic injury	411 (14.9)	255 (54.8)†	0 (0)	110 (64.7)•
Clinical characteristics	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
ISS	4.7 (6.4)	10.1 (9.6)†	11.4 (9.8)‡	18.2 (8.8)•
	Number (%)	Number (%)	Number (%)	Number (%)
Destination	879 (31.8)	227 (48.8)†	123 (58.6)‡	119 (70.0)•
Level I trauma centre	1887 (68.2)	238 (51.2)	87 (41.4)	51 (30.0)
Level II/III trauma centre				
Admission to hospital	1115 (40.3)	294 (63.2)†	145 (69.0)‡	155 (91.2)•
In-hospital death	45 (1.6)	18 (3.9)†	8 (3.8)	15 (8.4)•

AIS: Abbreviated Injury Score, SD: standard deviation, m: meters, ISS: Injury Severity Score.
Systolic blood pressure missed in 5.9%, diastolic blood pressure in 6.1%, pulse in 13.5%, respiratory rate in 6.3%, oxygen saturation in 9.9%, and Glasgow Coma Scale in 6.5%.
* The first vital signs assessed on-scene by the emergency medical services provider.
† Indicates a significant difference ($p < 0.05$) as compared to patients without a thoracic injury.
‡ Indicates a significant difference ($p < 0.05$) as compared to patients with a suspected thoracic injury.
• Indicates a significant difference ($p < 0.05$) as compared to patients without a severe thoracic injury.

Results

Participants

In total, 3658 trauma patients were transported by the ambulance services of *Central-Netherlands*. Among these patients, 551 were transported outside of the region and 430 were aged < 16 years old, Consequently, these patients were excluded. A total of 2766 patients were included in this study.

The mean patient age was 49 years (standard deviation: 22), 1695 (58.0%) were male, and 1115 (40.3%) were admitted to a trauma centre (Table 1).

Characteristics patients with thoracic injury

In total, 465 (16.8%) patients had a thoracic injury (AIS ≥ 1 in the thoracic region). In this group, 71.6% of the patients had an additional injury (AIS ≥ 1) to one or more body regions, most had an injury to the extremities (46.9%) or head (35.3%).

One hundred and seventy (36.6%) patients had a severe thoracic injury (AIS ≥ 3 in the thoracic region). In this group, 119 (70.0%) patients were transported to a level I trauma centre; the patients aged 65 years or older, with a severe thoracic injury, were less often transported to a level I trauma centre (41 patients out of 61, 67.2%), compared to patients aged 16–64 years old (78 patients out of 109, 71.6%).

Diagnostic value of EMS provider judgment

The EMS providers' judgment had a sensitivity of 54.8% (95%-confidence interval [95%-CI]: 50.3–59.3) and a specificity of 92.6% (95%-CI: 91.5–93.6) for the identification of a thoracic injury. The EMS providers suspected a thoracic injury in 51.8% of the patients with a mild or moderate thoracic injury (AIS 1 or 2 in the thoracic region) and in 64.7% of the patients with a severe thoracic injury (Table 2).

The EMS providers started cardiopulmonary resuscitation (CPR) on three patients with an unsuspected thoracic injury with an AIS of 4 or 5. The thoracic injuries (a tension pneumothorax, a major bilateral lung contusion, and a combined injury to the thoracic aorta and vena cava) might be a result of CPR. In the other patients with an unsuspected thoracic injury with an AIS of 4, the EMS providers did suspect injuries to other body regions, mostly to the extremities. One patient had an AIS of 6, this patient was dead on arrival. Among the patients with an unsuspected severe thoracic injury, 48 (80.0%) were transported to a level I trauma centre.

Predictors of a severe thoracic injury

Using univariable logistic analysis, 15 potential prehospital predictors of a severe thoracic injury were analysed (Table 3). Ten prehospital variables were significant with a p-value < 0.05 and entered in multivariable analysis. Significant independent prehospital predictors were: age, oxygen saturation, Glasgow Coma Scale, fall > 2 m, and suspicion of inhalation trauma or a thoracic injury by the EMS provider (Table 4).

Table 2
The number of patients with their AIS score.

AIS	Thoracic injury suspected Number (%)	No thoracic injury suspected Number (%)	Total Number
0	170 (7.4)	2,31 (92.6)	2,301
1	104 (53.1)	92 (46.9)	196
2	41 (41.4)	58 (58.6)	99
3	100 (65.4)	53 (34.6)	153
4	9 (64.3)	5 (35.7)	14
5	1 (50.0)	1 (50.0)	2
6	0 (0)	1 (100)	1

AIS: Abbreviated Injury Score.

Discussion

This study analysed the diagnostic value of EMS provider judgement, to gain insight in the accuracy of the prehospital assessment of thoracic injuries. In this study, almost one in five adult trauma patients suffered from a thoracic injury. The EMS providers' prehospital identification of a thoracic injury demonstrated a sensitivity of 55% and a specificity of 93%. Among the patients with a thoracic injury, over a third had a severe thoracic injury, of these the patients 30% was not transported to a level I trauma centre. Prehospital predictors of a severe thoracic injury were: age, gender, oxygen saturation, respiratory rate, Glasgow Coma Scale, fall > 2 m, car versus pedestrian with an impact > 10 km/h, entrapment in a vehicle, and suspicion of inhalation trauma or a thoracic injury by the EMS provider.

In the prehospital trauma triage process, EMS provider judgement is crucial, as they assess the injury severity, start treatment if necessary, and determine the destination facility of the patient. [14–16] In this study, the EMS providers' prehospital assessment demonstrated a high specificity, which could be explained by a low pre-test probability on thoracic injury. However, the low sensitivity is concerning; the EMS providers did not identify 45% of the patients with a thoracic injury. This is the first study to determine the diagnostic value of EMS providers of the ground ambulances in the identification of a thoracic injury. Previous studies assessed the ability of emergency physicians to identify thoracic injuries in a prehospital setting. Even though emergency physicians have had more education and training, the studies showed similar rates: thoracic injuries were unrecognized or underestimated in 20–50% of the cases [12,13,17,18].

Prehospital identification of injuries by anatomic region has been proven difficult, especially in patients suffering blunt trauma. [19] It has been previously reported that 10–15% of the patients with internal organ injuries of the thorax have no associated thoracic wall injury [20,21]. Penetrating trauma results in obvious visible injuries, however, it occurs in only a fraction of the whole trauma population in the Netherlands. The incidence of penetrating trauma differs per county and depends on regional circumstances, such as crime rates [22]. In the present study, only 2% of the patients with a thoracic injury suffered from penetrating trauma to the thorax. EMS providers use other findings, such as physical examination and vital signs, to identify all other thoracic injuries. However, previous studies showed that, for example auscultation, had a low sensitivity to identify thoracic injuries in the hospital setting [3,12,23,24]. It might even be of less benefit in prehospital setting, where time is crucial and potential other injuries may need attention. Also, the majority of patients with thoracic injuries have normal to near normal vital signs in the prehospital setting, so EMS providers may need additional criteria to identify these patients [3,12]. Patients with a thoracic injury often have injuries to other body regions and thoracic injuries are more often overlooked with higher rates of multiple injuries, leading to a delay in diagnosis at the hospital [25–27].

EMS providers must not only recognize the thoracic injury, but also try to determine if the injury is severe or not, to choose the most appropriate hospital for the patient. Currently, the EMS providers use a triage protocol that is not specific for patients at risk of a severe thoracic injury. [11] In the current study, 30% of the patients with a severe thoracic injury were not transported to a higher-level trauma centre. Clearly, improvement in the recognition of a severe thoracic injury is necessary. Extra training,

Table 3
Univariable binary logistic regression analysis.

					n = 2766
Variables	**Beta-coefficient**	**Standard error**	**P-value**	**Odds ratio**	**95% Confidence interval**
Demographic characteristics					
Age (decades)	0.133	0.036	< **0.001**	1.14	1.07 – 1.23
Male gender	0.497	0.170	**0.004**	1.64	1.18 – 2.30
Vital signs					
Systolic blood pressure < 90 mmHg	0.033	0.595	0.956	1.03	0.32 – 3.33
Oxygen saturation	−0.118	0.015	< **0.001**	0.89	0.86 – 0.92
Respiratory rate < 10 or > 29 /min	1.786	0.312	< **0.001**	5.97	3.23 – 11.02
Glasgow Coma Scale	−0.194	0.027	< **0.001**	0.82	0.78 – 0.87
Mechanism of injury					
Fall > 2 m	0.873	0.254	**0.001**	2.39	1.46 – 3.94
Fall from stairs	0.410	0.243	0.092	1.51	0.94 – 2.43
Car accident > 65 km/h	−0.057	0.353	0.872	0.95	0.47 – 1.89
Motorcycle accident > 32 km/h	0.378	0.379	0.319	1.46	0.70 – 3.06
Car vs pedestrian impact > 10 km/h	1.009	0.418	**0.016**	2.74	1.21 – 6.22
Car vs bike impact > 10 km/h	0.522	0.284	0.066	1.69	0.97 – 2.94
Entrapment in vehicle	2.571	0.611	< **0.001**	13.08	3.95 – 43.31
Injury characteristics					
Suspicion of inhalation trauma	3.842	1.157	**0.001**	46.62	4.82 – 450.58
Suspicion of thoracic injury	2.586	0.171	< **0.001**	13.28	9.49 – 18.58

AIS: Abbreviated Injury Scale, m: meters.
Bold indicates significant predictors of AIS ≥ 3 in the thoracic region with a p-value < 0.05.
Pulse missed in 13.5%, oxygen saturation in 9.9%, respiratory rate in 6.3%, and Glasgow Coma Scale in 6.5%.

Table 4
Multivariable logistic regression analysis.

					n = 2766
Variables	**Beta-coefficient**	**Standard error**	**P-value**	**Odds ratio**	**95% Confidence interval**
Demographic characteristics					
Age (decades)	0.126	0.044	**0.004**	1.14	1.04 – 1.24
Male gender	0.370	0.193	0.055	1.45	0.99 – 2.11
Vital signs					
Oxygen saturation	−0.080	0.020	< **0.001**	0.92	0.89 – 0.96
Respiratory rate < 10 or > 29 /min	0.793	0.415	0.057	2.21	0.98 – 5.00
Glasgow Coma Scale	−0.204	0.035	< **0.001**	0.82	0.76 – 0.87
Mechanism of injury					
Fall > 2 m	1.015	0.306	**0.001**	2.76	1.52 – 5.03
Car vs pedestrian impact > 10 km/h	1.161	0.509	0.023	3.20	1.18 – 8.67
Entrapment in vehicle	1.863	0.833	0.025	6.44	1.26 – 32.98
Injury characteristics					
Suspicion of inhalation trauma	3.513	1.417	**0.013**	33.55	2.09 – 539.46
Suspicion of thoracic injury	2.702	0.192	< **0.001**	14.91	10.23 – 21.71

AIS: Abbreviated Injury Scale, m: meters.
Bold indicates significant independent predictors of AIS ≥ 3 in the thoracic region with a p-value < 0.01.
Pulse missed in 13.5%, oxygen saturation in 9.9%, respiratory rate in 6.3%, and Glasgow Coma Scale in 6.5%.

education, and a supplementary or integrated protocol with prehospital predictors of a severe thoracic injury might improve the prehospital triage of these patients. The prehospital predictors of a severe thoracic injury found in this study could be used to develop a supplementary triage protocol. In this supplementary protocol, age and mechanism criteria could be included, in addition to vital signs, as the patients often have normal or near normal vital signs. (3,12)

In this study, a severe thoracic injury was defined as an injury to the thorax with an AIS ≥ 3. Previous studies have used this as a cut-off point [4,13,28,29], however, whether all patients with a thorax AIS ≥ 3 should be treated at a specialized thoracic trauma center remains unclear. Examples of AIS ≥ 3 thoracic injuries are: a hemothorax, three or more fractured ribs, or a laceration of a major artery or vein [30]. Previous studies have shown that patients with a severe thoracic injury often require Intensive Care Unit admission and are more at risk for adverse outcomes [28,31,32]. Therefore, transport to a higher-level trauma centre is justifiable -even though this is not mandated by a guideline of protocol- but depends on the trauma system. The identification of a severe thoracic injury especially important in the prehospital setting so the EMS provider can make a calculated destination decision; either a higher-level or a lower-level trauma center. Additionally, the EMS provider could consult the emergency physician before arrival at the trauma centre, to discuss if the proposed trauma centre is the most appropriate destination.

This study has several limitations. First, all patients who were transported outside the study region were excluded. This could have resulted in sampling bias. Second, the suspicion of a thoracic injury was based on the description of the patients' injuries in the ambulance services electronic records. The EMS providers' descriptions did not elaborate on the injury severity; only if an injury was suspected and to what body region. Because of this, analysis of the EMS provider judgment in the prehospital trauma triage process and on injury severity was not possible. Third, the diagnostic value of EMS provider judgment might vary in other

countries, as factors influencing EMS provider judgment, such as mechanism of injury, education, and patient population, could be different.

The identification of a thoracic injury is difficult, as most patients have normal to near normal vital signs and lack obvious injury characteristics for example. The EMS providers recognized little over half of the thoracic injuries. Prehospital trauma triage is especially important for the patients with severe thoracic injury. Future studies should focus on the development of a supplementary protocol for patients at risk for a severe thoracic injury. With data from other trauma regions, a prediction model could be developed and externally validated to help EMS providers identify patients with a severe thoracic injury. Including EMS provider judgement in this supplementary protocol could improve prehospital trauma triage of these patients further.

Conclusion

This study shows that the diagnostic value in the identification of a thoracic injury by EMS providers is insufficient. The EMS providers suspected a thoracic injury in 55% of the patients with a thoracic injury. Additional means to help identify these patients, such as a supplementary triage protocol, are necessary to improve prehospital trauma triage of patients with thoracic injury. This will improve their chances of survival and lower the chance of injury related life-long disabilities.

Conflicts of interest

None.

Transparency document

The Transparency document associated with this article can be found in the online version.

Acknowledgments

None.

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