Better compliance with triage criteria in trauma would reduce costs with maintained patient safety

Fredrik Linder[a], Lina Holmberg[a], Hampus Eklöf[b], Martin Björck[a], Claes Juhlin[a] and Kevin Mani[a]

Objective **To evaluate trauma triage criteria in terms of compliance, undertriage, and overtriage and identify risk factors for mistriage.**

Methods **In a retrospective cohort study, all consecutive trauma patients at a University Hospital in Sweden in 2012 were included. Patients were stratified into three groups on the basis of trauma team activation (full trauma team, limited trauma team, and no trauma team). Case records were reviewed for mechanism of injury, vital signs, and injuries. Compliance with alert criteria was evaluated and injury severity score combined with the Matrix method was used for assessment of overtriage and undertriage.**

Results **A total of 1424 trauma patients were included in the study. Seventy-three (5.1%) patients activated a full trauma team, 732 (51.4%) a limited trauma team, and 619 (43.5%) did not activate any trauma team. Undertriage was 2.7% [95% confidence interval (CI): 1.9–3.8%] and overtriage was 34.2% (95% CI: 23.5–46.3%) in the complete cohort. Compliance with 'trauma triage criteria' was assessed by comparing actual alerts with what was estimated to be the correct alert levels on the basis of prehospital case records. Compliance with full trauma team criteria was 80% (68–88%), limited trauma team was 54% (51–58%), and no trauma team was 79% (76–82%). Assuming full compliance with trauma criteria, the Matrix method resulted in an undertriage of 2.3% (95% CI: 1.6–3.3%) and an overtriage of 42.6% (95% CI: 32.4–53.2%).**

Conclusion **The overtriage and undertriage in this study is in line with the recommendations of the American College of Surgeons Committee on Trauma. However, better compliance with trauma alert criteria would result in fewer trauma team activations without affecting patient safety.** ***European Journal of Emergency Medicine*** **26: 283–288 Copyright © 2018 The Author(s). Published by Wolters Kluwer Health, Inc.**

European Journal of Emergency Medicine 2019, **26:**283–288

Keywords: advanced trauma life support care, multiple trauma, triage, wounds and injuries

[a]Department of Surgical Sciences, Section of Vascular Surgery and [b]Department of Surgical Sciences, Section of Radiology, Uppsala University, Uppsala, Sweden

Correspondence to Fredrik Linder, Ph Lic, Department of Surgical Sciences, Section of Vascular Surgery, Uppsala University, Akademiska sjukhuset, ing. 70 1tr, Uppsala 75185, Sweden
Tel: + 46 186 114 634; e-mail: fredrik.linder@surgsci.uu.se

Received 18 July 2017 **Accepted** 7 January 2018

Background

The use of triage criteria in a prehospital and inhospital setting has facilitated the early discovery of severely injured patients who may benefit the most from activation of a full trauma team and subsequent rapid diagnostics and treatments [1]. Compliance with current guidelines is an important factor to consider when assessing triage, and has been shown to vary in subgroups of trauma patients [2].

Triage in trauma is often initiated with a trauma alert, which is activated on the basis of predefined patient-specific physiologic criteria in combination with trauma mechanism. The efficiency of trauma alert criteria can be evaluated on the basis of calculation of undertriage and overtriage using the Matrix technique [3]. Undertriage is a medical problem commonly defined as a severely injured patient with an injury severity score (ISS) of more than 15 triaged to a limited or no trauma team 1, thus resulting in an increased risk of adverse outcomes. Overtriage is the overutilization of limited resources. It occurs when a patient who is not severely injured (ISS ≤ 15) is triaged to a full trauma team. To maintain undertriage at an acceptable level, defined as less than 5%, overtriage should range from 25 to 35% [1]. The most commonly used trauma alert triage criteria in Sweden 2012 were based on 'Resources for Optimal Care of the Injured Patient 2006' and the 'Rapid Emergency Triage and Treatment System in Trauma' [3]. According to studies carried out in trauma centers with a high burden of high-energy and penetrating trauma, these criteria result in acceptable undertriage and overtriage [4]. The efficacy of triage criteria may, however, be affected by the development of new preventive measures (e.g. improved motor vehicle safety), as well as variations in mechanism of injury (MOI) between centers. In addition, medical professionals' compliance with specific trauma alert criteria may affect the efficacy of the triage system to accurately identify severely injured patients without overuse of limited resources.

This is an open-access article distributed under the terms of the Creative Commons Attribution-Non Commercial-No Derivatives License 4.0 (CCBY-NC-ND), where it is permissible to download and share the work provided it is properly cited. The work cannot be changed in any way or used commercially without permission from the journal.

0969-9546 Copyright © 2018 The Author(s). Published by Wolters Kluwer Health, Inc. DOI: 10.1097/MEJ.0000000000000544

Copyright © 2018 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

In the current study, trauma triage criteria were evaluated in terms of compliance, undertriage, overtriage, and risk factors for mistriage. The hypothesis was that low compliance with trauma alert criteria, defined as less than 70%, was a contributing factor to excessive overtriage and that improved compliance would result in decreased overtriage and undertriage.

Methods

A retrospective cohort study was carried out and all consecutive trauma patients presenting to the Surgical Emergency Unit at Uppsala University Hospital, a Tertiary Referral Trauma Center in Sweden, during 2012 were included. Medical records were retrieved and information on age, sex, MOI, prehospital vital signs and suspected injuries, trauma team activation, and ISS was extracted.

The ISS was calculated using the Abbreviated Injury Score (AIS08), where every injury is graded on the basis of severity and topography. The scale ranges from 1 (minor) to 6 (lethal) [5]. The ISS is the sum of the square of the three highest AIS. Patients with an ISS more than 15 are considered severely injured. Overtriage and undertriage were calculated using the Matrix method [1]. In this analysis, trauma patients are grouped according to the level of alert (full trauma alert or not) and injury severity (dichotomized as ISS > 15, severely injured; ISS ≤ 15, not severely injured). Full trauma team activation without severe injury is considered as overtriage. No or limited trauma team activation in a patient with severe injury is considered as undertriage.

Inhospital triage was performed by a senior nurse when contacted by the prehospital personnel or by a senior anesthesiologist in the medical helicopter service. Triage criteria are summarized in Table 1. Compliance with trauma team alert criteria was evaluated by studying the prehospital reports and assessing the indication for trauma alert activation (including data on prehospital vital parameters and MOI), resulting in a retriage of the patients. The triage classification made by the senior nurse at our emergency department was compared with the retriage. Compliance with alert criteria was evaluated on the basis of MOI, the use of in line stabilization devices, presence of blood alcohol, and medical competence in the prehospital organization.

Statistics

Data were assessed for normality with histograms. Categorical data were reported as ratios with 95% confidence intervals (CIs), and were assessed using the χ^2-test. Normally distributed continuous data were reported as means with SD, and were compared using Student's *t*-test. The study groups were compared with confidence intervals. Predictors for lack of compliance with triage criteria were assessed in a univariate logistic regression analysis. Statistical analyses were carried out with IBM SPSS, version 23 (IBM Corp., Armonk, New York, USA).

Ethics approval and consent to participate

The regional Ethics Committee in Uppsala, Sweden, reviewed the study (Dnr 2014–250). The committee waived the need for informed consent and formal ethical assessment for this retrospective cohort study.

Results

Overtriage and undertriage

A total of 1461 patients were identified and 37 patients were excluded because of various reasons stated in the flowchart (Fig. 1). A total of 1424 patients were included in the study and 73 (5.1%) patients activated a full trauma team, 732 (51.4%) activated a limited trauma team, and 619 (43.5%) did not trigger activation of any trauma team. Patient characteristics are summarized in Table 2.

The mean ISS for the full trauma team was 23.5 (21.1 SD) and that for the limited trauma team was 3.5 (5.3 SD). The distributions of ISS in the different groups are shown in histograms (Fig. 2)) and the Matrix method for overtriage and undertriage was calculated, resulting in an undertriage of 2.7% (95% CI: 1.9–3.8%) and an overtriage of 34.2% (95% CI: 23.5–46.3%). Subgroup analyses of overtriage and undertriage on the basis of MOI are reported in Table 3. Undertriage was highest among

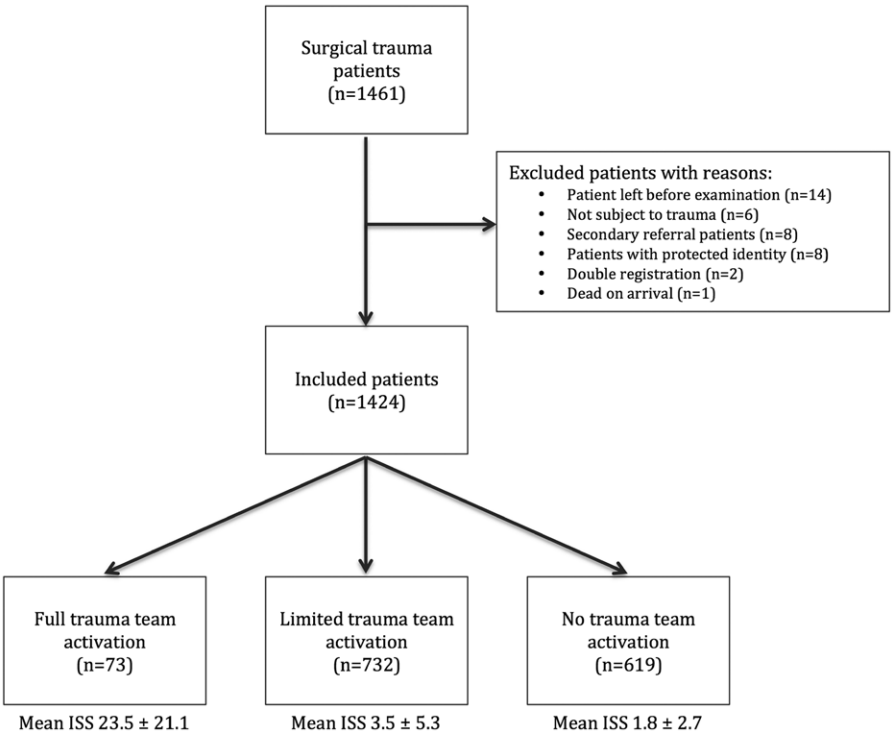
Table 1 Trauma alert guidelines

Trauma patient	High-energy trauma criteria		Compromise to vital functions	Specific injuries
Registered as surgical trauma patient at the emergency department	MVC >70 km/h with seatbelt	A	Obstructed airway	Penetrating trauma to the abdomen, chest, or neck
	MVC >50 km/h without seatbelt	B	Respiratory rate >30 or <8/min	≥2 fractures of long bones
	Extrication time >30 min		SpO_2 <90% with supplement of oxygen	Pelvic fracture without stability
	Thrown out of vehicle		Diminished breath sounds	Traumatic amputation above hand or foot
	Casualty in same vehicle	C	Systolic BP <90 mmHg	Burn >18% or inhalation burn
	MCC >30 km/h		Pulse >120 bpm	Drowning or hypothermia
	Pedestrian or bicyclist hit by vehicle	D	GCS<13	Flail chest
	Fall >3 m in height		Focal neurologic deficit	Spine fractures
No trauma team activation	Limited trauma team activation		Full trauma team activation	

Regionally modified criteria for trauma alert calls and risk group assessment.
BP, blood pressure; MVC, motor vehicle crashes; GCS, Glasgow Coma Scale; SpO_2, oxygen saturation.

Copyright © 2018 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

Fig. 1



Flowchart of patients included. After subdivision into the studied groups. ISS, injury severity score.

Table 2 Patient characteristics according to level of alert

	No trauma team (*n*=619)	Limited trauma team (*n*=732)	Full trauma team (*n*=73)	*P*-value*
Age [mean (SD)] (years)	40.0 (21.3)	41.4 (20.6)	42.7 (22.4)	0.60
Sex (male) [*n* (%)]	319 (51.5)	455 (62.2)	59 (80.8)	0.02
Injury severity score [mean (SD)]	1.8 (2.7)	3.5 (5.3)	23.5 (21.1)	<0.001
New injury severity score [mean (SD)]	2.0 (3.1)	3.9 (6.2)	25.7 (21.2)	<0.001
Examined by whole-body computer tomography in trauma [*n* (%)]	50 (8.1)	275 (37.6)	59 (80.8)	<0.001
Specific radiological exams [*n* (%)]	227 (36.7)	441 (60.2)	35 (47.9)	0.04
Admission to ICU [*n* (%)]	2 (0.3)	23 (3.1)	46 (63.0)	<0.001

After subdivision into the studied groups.
**P*-value on the basis of comparison between limited trauma team and full trauma team.

the patients with a fall trauma of more than 3 m height and lowest in motor vehicle crashes (MVC). Eighteen penetrating injury patients were present in this cohort (1.3% of all trauma cases): 15 stab wounds and three gunshot wounds. The majority of these patients (15/18) were triaged to a full trauma team on the basis of the presence of penetrating trauma to the abdomen, chest, or neck.

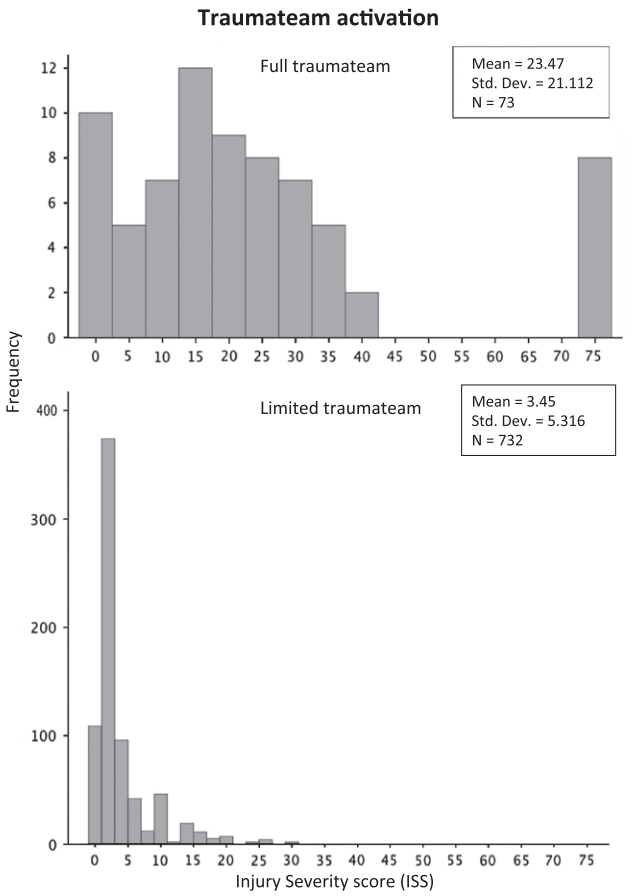
Total inhospital mortality was 18 patients, with the distribution of 10 patients, 13.7% (95% CI: 6.8–23.8%) in the full trauma team group, seven patients, 1.0% (95% CI: 0.4–2.0%) for the limited trauma team group, and one trauma mortality, 0.16% (95% CI: 0–0.9%) in the group of patients who did not trigger a trauma team. Initial triage was correct in 67% (95% CI: 41.0–86.7%) of these patients. On the basis of a subgroup analysis of the patients who had been subjected to overtriage according to the Matrix model ($n=25$), 5 (20%) of these patients needed an urgent intervention (intubation, chest-tube placement, blood transfusion, or urgent laparotomy), which thus led to the full trauma team activation despite ISS up ≤ 15. There was no difference in mortality for patients who activated a full trauma team versus undertriaged patients, with 15.1% (95% CI: 7.8–25.4%) and 18.9% (95% CI: 8.0–35.2%), respectively.

Compliance with triage criteria

Compliance with full trauma team triage criteria was 80% (95% CI: 68–88%), whereas compliance with limited trauma team triage criteria was 54% (95% CI: 51–58%) ($P<0.001$). For triage to 'no trauma team', compliance was 79% (95% CI: 76–82%). The compliance with criteria was less than 60% for equestrian accidents and fall injuries less than 3 m in height.

Copyright © 2018 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

Fig. 2



`Histogram of distributions of injury severity score (ISS) according to alert level. After subdivision into the studied groups.

Table 3 Overtriage and undertriage with the matrix method according to the mechanism of injury

	Undertriage (%)	95% CI	Overtriage (%)	95% CI
Motor vehicle crashes*	0.4*	0.1–0.9	47.1**	27.8–77.0
Motorcycle crashes	5.0	1.4–12.3	0.0	0.0–52.2
Bicycle crashes	3.8	1.3–8.7	0.0	0.0–45.9
Equestrian accidents	4.9	1.3–12.0	100.0	–
Pedestrians hit	5.9	0.1–28.7	20.0	0.5–71.6
Fall injuries <3 m in height	5.8	3.3–9.4	50.0	1.3–98.7
Fall injuries >3 m in height	11.6	3.9–25.1	27.3	6.0–61.0
Other injuries	4.7	2.1–9.1	38.5	20.2–59.4
All injuries	2.7	1.9–3.8	32.9	22.3–44.9

After subdivision into the studied groups.
CI, confidence interval; MOI, mechanism of injury; MVC, motor vehicle crashes.
*Risk of undertriage significantly less in MVC compared with all other MOI ($P < 0.001$).
**Risk of overtriage in MVC is not significantly higher than all other MOI ($P = 0.432$).

Assuming full compliance with the trauma alert criteria on the basis of prehospital medical records, an assessment of the undertriage and overtriage with the Matrix method resulted in an undertriage of 2.3% (95% CI: 1.6–3.3%) and an overtriage of 42.6% (95% CI: 32.4–53.2%). Full compliance with triage criteria would thus have resulted in 301 trauma alerts not being activated and 129 additional trauma alerts in patients who currently did not activate trauma alert. Full trauma team activation was missed in 36 patients who fulfilled the criteria and 15 patients wrongfully triggered a full trauma team. Limited trauma team activation was missed in 141 patients who fulfilled the criteria and 334 patients wrongfully triggered limited trauma team activation.

Risk factors for lack of compliance with triage criteria

Risk factors for lack of compliance with triage criteria with odds ratios were calculated in Table 4. The presence of alcohol in blood tests and immobilization with a long spine board or Kendrick Extrication Device were both risk factors for the patients being triaged to the wrong group. Low fall injuries and equestrian injuries were also risk factors for lack of compliance with triage criteria.

To assess the effect of personnel experience on triage compliance, a specific analysis was carried out for the patients triaged during the summer period from 1 June to 31 August. During this time period, a higher proportion of the emergency department staff performing triage are summer locums with less triage experience. There was no difference in compliance with alert criteria (full trauma alert 76%, 95% CI: 53–92%; limited trauma alert 56%, 49–63%; no trauma alert 77%, 70–83%).

Discussion

Triage of trauma patients on the basis of information collected by prehospital personnel on MOI, vital signs, and specific types of injuries will inevitably result in both overtriage and undertriage [6–8]. In our study, triage was performed by a specific triage nurse with an overtriage of 33% and an undertriage of 4%. In a Norwegian study, the rate of overtriage and undertriage varied depending on who performed the triage: 35% overtriage and 2% undertriage for prehospital anesthesiologists versus 66% overtriage and 17% undertriage for paramedics [9].

This study indicates that trauma triage criteria are used with acceptable undertriage and overtriage [1,10] in the setting of a Scandinavian trauma environment. The

Table 4 Univariate analysis of predictors for mistriage

Risk factor	Odds ratio	95% CI	*P*-value
Motor vehicle crashes	0.76	0.61–0.95	0.016
Motorcycle crashes	0.76	0.47–1.24	0.278
Bicycle crashes	0.86	0.59–1.26	0.438
Equestrian accidents	3.05	1.94–4.80	<0.001
Pedestrians hit	0.74	0.29–1.89	0.526
Fall injuries <3 m in height	1.51	1.14–1.99	0.004
Fall injuries >3 m in height	0.68	0.37–1.27	0.224
Blood alcohol >15 mmol/l	2.17	1.49–3.13	<0.001
Patient immobilized on a long spine board/Kendrick Extrication Device	1.75	1.41–2.17	<0.001
Sex (male)	0.98	0.78–1.22	0.838
Brought in by HEMS	1.20	0.67–2.14	0.535
Age >55 years	0.98	0.76–1.25	0.848

After subdivision into the studied groups.
CI, confidence interval; HEMS, Helicopter Emergency Medical Service.

Copyright © 2018 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

American College of Surgeon's Committee on Trauma has indicated that an overtriage of 25–35% and undertriage of 5% can be considered acceptable 1. However, improved compliance may result in reduction of unnecessary trauma alert activation. In addition, the study indicates that undertriage and overtriage may be above acceptable levels for specific types of trauma mechanisms.

To our knowledge, there are only a limited number of publications assessing trauma triage compliance in a modern Scandinavian setting, some on isolated head injuries [11], and some on inhospital triage with a small cohort [2]. The current paper presents triage compliance in a large number of consecutive patients presenting to the surgical emergency unit at a tertiary referral hospital. Although the data were collected in 2013, there is no indication of change of trauma panorama in Sweden affecting the results. Admittedly, the current paper is limited by its retrospective nature; however, an attempt to conduct a prospective trauma triage trial in Sweden by the authors was denied ethical approval because of the fact that it is not possible to collect informed consent from trauma patients before triage.

The Matrix method is a simple way to evaluate triage, but the correlation between ISS and the requirements of the trauma patient can be questioned. A different approach in evaluating team activation could be assessing the need for urgent intervention, invasive monitoring, or the Glasgow Outcome Scale.

In the current study, five independent risk factors for a patient being triaged to an inadequate level of trauma alert were identified; three of these were specific MOI. Immobilized patients and patients with alcohol intoxication were also more likely to be triaged to the wrong level of trauma alert. Undertriage is a medical problem, and failing to recognize a severely injured patient may lead to worse outcome. Patients on Warfarin, age more than 64 years, and patients with neurosurgical injuries are more likely to be undertriaged [12–14]. Although there is some evidence to suggest that falls at least 5 m are a relevant predictor of severe injury [15,16], our results show that patients with falls more than 3 m are undertriaged.

In this study, undertriage of MVC is very low (0.4%). Car safety is constantly improving, which may reduce the traumatic injuries associated with MVCs. Trauma triage criteria on the basis of MOI alone are more likely to lead to overtriage [15,17], whereas specific types of injuries and hypotension tend to be more sensitive [10,18]. In Norway, the national center for competence in trauma care has recently removed MVC as a stand-alone criterion for trauma alert [19]. The trauma alert criteria used in Sweden have recently been revised and are currently being implemented nation-wide. In the revised Swedish guidelines, high-speed MVC in combination with not wearing a seatbelt or when the patient is ejected from the vehicle is still used as MOI for a limited trauma alert. A study to evaluate the validity of the revised trauma alert criteria using the Swedish trauma registry has been initiated.

The lack of compliance with predefined triage criteria may affect the outcome of trauma care, as well as use of resources. In the current study, the compliance with full trauma alert criteria was 80% and compliance with limited trauma alert criteria was as low as 54%. In general, a better compliance would have resulted in a lower total number of trauma team activations. The high number of trauma team activations is not a medical problem, but it occupies medical staff who could be needed elsewhere. This is especially the case during on-call hours, when resources are limited and demand can sometimes be high. Importantly, better compliance would have sustained adequate levels of overtriage and undertriage.

Limitations

Although the prehospital report and MOI have been thoroughly evaluated during data collection, the retrospective nature of this study introduces a risk of bias. A limitation of the current study is that the assessment of compliance with alert criteria, which was based on the evaluation of prehospital records, is a risk for bias. However, we found that the prehospital records were mostly of good quality with extensive information on vital parameters, suspected injuries, and MOI, thus containing sufficient data to perform an adequate assessment of the correct triage level of the patients retrospectively. The differences in the use of whole-body computed tomography (WBCT) between groups could potentially lower the ISS among patients who were not examined by WBCT, creating a selection bias. Therefore, an even distribution of WBCT between the groups would have been preferable. In a previous analysis [20], we examined the correlation between findings at physical examination and the use of WBCT. The study showed that patients with minor findings at physical examination did not have any 'missed injuries' at WBCT.

Conclusion

Our results show an overtriage and undertriage of 34.2 and 2.7%, respectively, which is considered acceptable according to the American College of Surgeons Committee on Trauma. However, a lack of compliance, mainly in the limited trauma alert group, resulted in an overactivation of trauma alert teams in 37% of patients and was a contributing factor to excessive overtriage. Further improvement of compliance with established trauma alert criteria may optimize resource allocation, without compromising patient safety and with adequate levels of overtriage and undertriage.

Acknowledgements

F.L. conceived the study idea, designed the study, recorded and analyzed the data, and drafted the manuscript. L.H.

Copyright © 2018 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.

contributed to study design, recording, and analyzing the data, and drafting the manuscript. M.B. contributed to study design, data analysis, and critical reviewing of the manuscript. C.J. contributed to study design, data analysis, and drafting the manuscript. H.E. contributed to study design, data analysis, and drafting the manuscript. K.M. contributed to conceiving the study idea, the study design, data analysis, and drafting the manuscript. All authors have read and approved the final manuscript.

Conflicts of interest

There are no conflicts of interest.

References

1 American College of Surgeons Committee on Trauma. *Resources for optimal care of the injured patient 2014*, 6th ed. Chicago, IL: ACS-COT; 2014.
2 Christensen D, Jensen NM, Maaloe R, Rudolph SS, Belhage B, Perrild H. Low compliance with a validated system for emergency department triage. *Dan Med Bull* 2011; **58**:A4294.
3 Widgren BR, Jourak M. Medical Emergency Triage and Treatment System (METTS): a new protocol in primary triage and secondary priority decision in emergency medicine. *J Emerg Med* 2011; **40**:623–628.
4 Widgren BR, Nilsson G, Ortenwall P. More efficient trauma care with prehospital METTS-T triage. A simple and medically safe method according to a retrospective study. *Lakartidningen* 2009; **106**:746–749.
5 Osler T, Baker SP, Long W. A modification of the injury severity score that both improves accuracy and simplifies scoring. *J Trauma* 1997; **43**:922–925; [discussion 925–926]
6 Lehmann R, Brounts L, Lesperance K, Eckert M, Casey L, Beekley A, *et al*. A simplified set of trauma triage criteria to safely reduce overtriage: a prospective study. *Arch Surg* 2009; **144**:853–858.
7 Curtis K, Olivier J, Mitchell R, Cook A, Rankin T, Rana A, *et al*. Evaluation of a tiered trauma call system in a level 1 trauma centre. *Injury* 2011; **42**:57–62.
8 Fitzharris M, Stevenson M, Middleton P, Sinclair G. Adherence with the pre-hospital triage protocol in the transport of injured patients in an urban setting. *Injury* 2012; **43**:1368–1376.
9 Rehn M, Eken T, Kruger AJ, Steen PA, Skaga NO, Lossius HM. Precision of field triage in patients brought to a trauma centre after introducing trauma team activation guidelines. *Scand J Trauma Resusc Emerg Med* 2009; **17**:1.
10 Henry MC, Hollander JE, Alicandro JM, Cassara G, O'Malley S, Thode HC Jr. Incremental benefit of individual American College of Surgeons trauma triage criteria. *Acad Emerg Med* 1996; **3**:992–1000.
11 Heskestad B, Waterloo K, Ingebrigtsen T, Romner B, Harr ME, Helseth E. An observational study of compliance with the Scandinavian guidelines for management of minimal, mild and moderate head injury. *Scand J Trauma Resusc Emerg Med* 2012; **20**:32.
12 Dehli T, Monsen SA, Fredriksen K, Bartnes K. Evaluation of a trauma team activation protocol revision: a prospective cohort study. *Scand J Trauma Resusc Emerg Med* 2016; **24**:105.
13 Chang DC, Bass RR, Cornwell EE, Mackenzie EJ. Undertriage of elderly trauma patients to state-designated trauma centers. *Arch Surg* 2008; **143**:776–781. [discussion 782].
14 Rogers A, Rogers FB, Schwab CW, Bradburn E, Lee J, Wu D, *et al*. Increased mortality with undertriaged patients in a mature trauma center with an aggressive trauma team activation system. *Eur J Trauma Emerg Surg* 2013; **39**:599–603.
15 Uleberg O, Vinjevoll OP, Eriksson U, Aadahl P, Skogvoll E. Overtriage in trauma – what are the causes? *Acta Anaesthesiol Scand* 2007; **51**:1178–1183.
16 Boyle MJ, Smith EC, Archer F. Is mechanism of injury alone a useful predictor of major trauma? *Injury* 2008; **39**:986–992.
17 Esposito TJ, Offner PJ, Jurkovich GJ, Griffith J, Maier RV. Do prehospital trauma center triage criteria identify major trauma victims? *Arch Surg* 1995; **130**:171–176.
18 Dehli T, Fredriksen K, Osbakk SA, Bartnes K. Evaluation of a university hospital trauma team activation protocol. *Scand J Trauma Resusc Emerg Med* 2011; **19**:18.
19 Wisborg T, Gaarder C, Geisner T, Rolandsen BA. Nasjonal traumeplan–Traumesystem i Norge 2016. Tidsskrift for den Norske laegeforening: tidsskrift for praktisk medicin, ny raekke. *Scand J Trauma Resusc Emerg Med* 2017; **137**:20.
20 Linder F, Mani K, Juhlin C, Eklof H. Routine whole body CT of high energy trauma patients leads to excessive radiation exposure. *Scand J Trauma Resusc Emerg Med* 2016; **24**:7.

Copyright © 2018 Wolters Kluwer Health, Inc. Unauthorized reproduction of this article is prohibited.