Visitation by physicians did not improve triage in trauma patients

Lars Andreas Holm Burén[1], Morten Daugaard[2], Jens Kjærgaard Rolighed Larsen[3, 4] & Torben Krabbe Laustrup[3]

ABSTRACT

INTRODUCTION: A formalized trauma response team is designed to optimize the quality and progress of patient care for severely injured patients in order to reduce mortality and morbidity. The goal of this study was to determine over- and undertriage and to evaluate if a physician-manned pre-hospital response (MD-EMS) would reduce overtriage. Overtriage was defined as the process of overestimating the level of injury sustained by an individual.

MATERIAL AND METHODS: This was a retrospective study. All patients admitted with trauma team activation (TTA) (n = 1,468) during a four-year period (2007-2011) were included. Undertriage was estimated by assessing the fraction of major trauma patients (New Injury Severity Score (NISS) > 15) admitted to Viborg Regional Hospital in the project period without TTA.

RESULTS: For each year, overtriage was 88.3% (2007), 89.9% (2008), 92.8% (2009) and 88.2% (2010); an NISS > 15 was seen in a total of 149 patients. Undertriage was 0.39% (2007), 0.46% (2008), 0.51% (2009) and 1.10% (2010); an NISS > 15 was seen in a total of 21 patients who were not received by a trauma team. We observed no significant difference in the NISS (p = 0.19) or in over-/undertriage (p = 0.76 and p = 0.058) when comparing the years before with the years after the introduction of the MD-EMS response.

CONCLUSION: Our study shows a high degree of overtriage and a very low undertriage according to the currently accepted protocol guidelines. No effect was seen after the introduction of the MD-EMS.

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Annually, a total of 2,000 Danes die as a result of accidents, which are the leading cause of death in people aged 1-34 years of age. Accidents occupy a fourth place in terms of life years lost among men and an eighth place among women. Accidents are also associated with loss of earnings due to illness and injury on the part of the victim [1]. A formalized trauma response team is designed to optimize the quality and progress of patient care for severely injured patients in order to reduce mortality, morbidity, complications and bed days. Studies have shown that the mortality rate is significantly reduced when injured patients are received by multidisciplinary trauma teams [2, 3]. In Denmark, there are currently no national guidelines on trauma care (only various regional guidelines), including no national visitation guidelines to ensure early recognition of those patients who can be treated at a regional trauma centre, and whose who should be transferred to one of the four highly specialised trauma centres, equivalent to The American College of Surgeons Committee on Trauma (ACS-COT) level 1 centre. This problem was already discussed in 2001 [4].

Overtriage (the process of overestimating the level of injury an individual has sustained) causes unnecessary mobilization of personnel. This has adverse effects on the treatment of non-trauma patients; thus, studies have shown an increased length of stay and longer time from arrival to physician evaluation [5, 6]. Overtriage therefore causes delays and/or cancelation of planned operations and procedures.

Undertriage (the process of underestimating the severity of an injury) leads to injured patients not receiving the quality of treatment that they deserve and neglected injuries can increase the risk of permanent injury or death [7]. It is impossible to avoid some degree of mistriage. ACS-COT considers that an undertriage of 5% and an overtriage of 25-50% are acceptable [8]. It is important to have a triage system that accommodates both patient safety and optimal use of resources in health care.

Each year the trauma centre at Viborg Regional Hospital receives nearly 350 patients who trigger a trauma team activation (TTA) according to the regional pre-hospital guidelines for trauma (**Table 1**). A TTA is activated when a patient scores two points or more. Additionally, the emergency department receives almost 30,000 patients with minor injuries.

We wanted to assess the over- and undertriage of the existing regional pre-hospital guidelines for trauma. On 1 July 2009, Viborg Regional Hospital began dispatching pre-hospital anaesthetists (MD-EMS) to accidents in addition to the local emergency medical services (EMS) personnel. The present paper explores whether this highly qualified pre-hospital assessment reduced overtriage regardless of the visitation protocol.

MATERIAL END METHODS

Participant recruitment

We performed a retrospective analysis of trauma triage at Viborg Regional Hospital from 1 July 2007 to 31 April 2011. Since 2007, all TTA at Viborg Regional Hospital

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1) Department of Anaesthesia and Surgery, Viborg Regional Hospital
2) Centre for Elective Surgery, Silkeborg Regional Hospital
3) Department of Anaesthesiology and Intensive Care, Viborg Regional Hospital
4) Institute of Clinical Medicine, Aarhus University

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TABLE 1

Viborg Regional Hospital trauma team activation criteria. The current trauma protocol utilizes a rating system that assigns points ranging from zero to two.

	Rating system points		
	0	1	2
Level of consciousness	Awake	Clear	Unconscious
	GCS 15	GCS 13-14	GCS < 13
		Momentarily unconscious	
Respiratory system	Normal	Laboured	Saturation < 90%
			Frequency < 10 or > 30
Circulation	Systolic blood pressure > 90 mmHg		Systolic blood pressure < 90 mmHg
Thorax	Soreness/mild soreness	In pain	Open lesions
Abdomen	Not sore/mild soreness	In pain	Open lesions
Neck/spine	Not sore	In pain or pain on palpation	Paralysis, tingling in the arms or legs
Fractures, arms/legs/pelvis	No indication	2 limb fractures	Open fracture, > 2 fractures, pelvic fracture, amputation
Mechanism of injury	Low energy	Vulnerable road user[b] or high energy trauma[c]	Burn: children >10%, adults > 15%
Age[a]		< 12 yrs, > 75 yrs	

GCS = Glasgow Coma Scale; TTA = trauma team activation.
a) Children, elderly or significant co-morbidity; children, younger than 12 years (approx.): regarding other injuries than minor fractures of arms and legs; older than 75 years: all age groups with known significant co-morbidity.
b) Scooter/motorcycle – accidents at low speed; bicycles – high speed; bicycles/pedestrians hit by car/motorcycle; solo – motorcycle without helmet at low speed.
c) Ejected from vehicle; co-passenger dead; trapped in wreck; frontal collision/collision against fixed object; considerable deformation of vehicle or has rolled over; fall > 6 m.

TABLE 2

Patient characteristics.

	TTA prior to MD-EMS		TTA after introduction of MD-EMS	
	2007 (N = 384)	2008 (N = 366)	2009 (N = 375)	2010 (N = 339)
NISS > 15, n	45	37	27	40
Sex M/F, n	245/140	239/127	241/135	220/121
Age, median, yrs	31.00	31.00	29.50	30.00
Penetrating trauma, n (%)	8 (2.1)	2 (0.6)	5 (1.3)	1 (0.3)
Blunt trauma, n (%)	264 (68.6)	261 (71.3)	253 (67.0)	242 (71.0)
NISS, mean	5.68	4.84	4.09	5.37
NISS, median	2	2	1	2
Overtriage, %	88.3	89.9	92.8	88.2
Undertriage, %	0.39	0.46	0.51	1.1

F = female; M = male; MD-EMS = physician-manned pre-hospital response; NISS = New Injury Severity Score; TTA = trauma team activation.

have been registered at the Orthopaedic Department, whereby a registry has been created of all traumas received at Viborg Regional Hospital. The registry is organized by the centralised Civil Registration System. A list was generated of all trauma patients admitted to Viborg Regional Hospital in this period. Initially, 1,494 patients were registered; 26 were subsequently excluded (21 because they had been incorrectly coded and five due to missing records); this yielding a total of 1,468 included patients. Patient charts including imaging were recorded via the hospital electronic patient registry.

To identify the patients with major trauma that initially might have been missed at the pre-hospital assessment and who therefore had not triggered a TTA, we generated a list of all orthopaedic and general surgical patients admitted to the Intensive Care Unit (ICU) and the Intermediate Care Unit (IMU) at Viborg Regional Hospital during the project period. The search was limited to patients registered with trauma injuries. We then excluded all patients who had been admitted via a TTA, those who had been hospitalized > 24 hours and those who had been transferred from another trauma centre. Initially, 1,152 patients were registered, and then 1,070 were excluded (1,017 With TTA, 11 transferred from other hospitals, 18 wrongly coded and one hospitalized > 24 hours). The final study population included 82 patients.

Our analysis is based on a total of 1,550 patients.

End-points

The trial had two primary end-points. One was an estimation of under- and overtriage. Overtriage was estimated by calculating the fraction of patients with only minor trauma in the cohort of patients who triggered a TTA. The severity of injury was assessed via the Abbreviated Injury Scale 2005 (AIS) [9] as per tradition and according to practice; patients with an New Injury Severity Score [10, 11] an NISS ≤ 15 were considered having minor trauma, and patients with an NISS > 15 were considered having major trauma [12] because of a mortality risk of at least 10%. New studies are questioning this division [13], but we stuck to this definition because of the long tradition for its use. Undertriage was estimated by assessing the fraction of major trauma patients (NISS > 15) admitted to Viborg Regional Hospital in the project period without TTA. These patients were identified on the assumption that in a Danish hospital setting, any se-

verely injured patient will at some point be admitted to the ICU or IMU. The other primary end-point was to determine if there was a difference in over- and undertriage after the introduction of the MD-EMS

Secondary end-points included NISS before and after the introduction of the MD-EMS, patient characteristics and demographic data.

Ethics

In compliance with the Scientific Committees for the Region of Central Jutland, we acquired approval for our project prior to collecting data.

Statistics

All values are expressed as mean ± standard deviation (SD (error bars)) unless otherwise stated. All demographic data and NISS data were tested for normal distribution using the D'Agostino-Pearson test. Group demographic data and NISS comparisons were made using non-parametric analyses (Mann-Whitney rank sum test for independent samples) and are graphically represented by mean (95% confidence interval (CI)). Overtriage comparisons were made using comparison of two rates and Fisher's exact test for undertriage because of the limited number of observations. In some instances, a comparison of medians is most relevant, in which case this is stated. For all analyses, $p < 0.05$ was considered to reflect a significant difference. MedCalc 12.5.0.0 (Ostend, Belgium) was used in the analysis and presentation of the results.

Trial registration: In compliance with the Scientific Committees for the Region of Central Jutland, approval for our project was acquired prior to collecting data.

RESULTS

Main characteristics

Of the 1,468 patients received by the trauma team, blunt trauma dominated (69.5%). See other main characteristic in **Table 2**. Motor vehicle traffic crash was the leading mechanism of injury among the total number of admitted trauma patients. The leading mechanisms of injury among trauma system patients with an NISS > 15 are almost equally shared by motor vehicle traffic crash, pedestrian/cyclist/motorcycle traffic crash and fall (**Figure 1**). Men suffered significantly higher NISS scores than women did ($p = 0.001$).

Overtriaged patients

Overtriage ranged from 88.3 to 92.8% evaluated against injuries with an NISS > 15 with TTA (149 patients in total) (Table 2).

Undertriaged patients

Undertriage was 0.39 to 1.1% evaluated against injuries with an NISS > 15 without TTA (21 patients in total). Only 17.6% were triaged by an anaesthetist and 66.7% had head injuries only. The median age was 72.5 years (19-81 years) (Table 2).

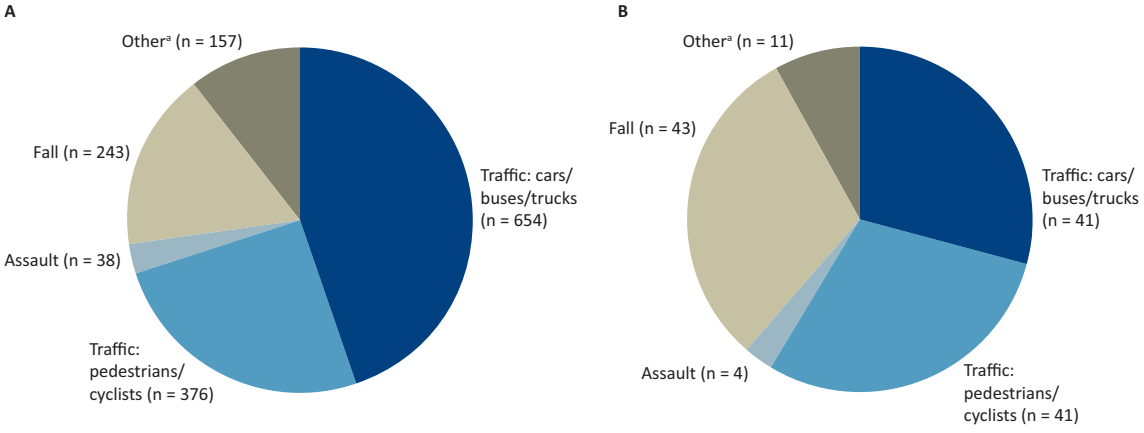
Evaluation of pre-hospital triage

There were no statistically significant differences in NISS between the years before and after the MD-EMS (**Figure 2**). Nor was there any statistical difference between over- and undertriage ($p = 0.76$ and $p = 0.058$) and between the two periods.

DISCUSSION

We report a high degree of overtriage and a very low

FIGURE 1

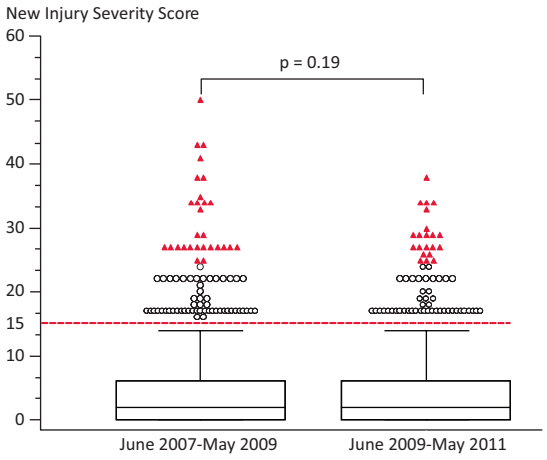


Mechanism of injury in trauma patients.
A. Total (N = 1,486).
B. NISS >15 (N = 140).

NISS = New Injury Severity Score.
a) includes aircraft, watercraft, animal, sports, explosive decive, building collapse, struck by falling object, penetrating (no assault), unknown.

FIGURE 2

Difference in New Injury Severity Score before and after introduction of physician-manned pre-hospital response. The figure is a standard box and whisker plot showing median, interquartile range (IQR), 25th and 75th percentiles, outliers > 1.5 × IQR (circles) and far outliers > 3 × IQR (red triangles).



degree of undertriage when receiving trauma patients at Viborg Regional Hospital. Furthermore, no difference was found in the triage of patients before versus after the commencement of the MD-EMS pre-hospital response.

We cannot comment on the parameters that may have caused overtriage, nor directly on how to improve the trauma protocol. Dehli et al [14] assessed the predictive value of each criterion included in the local Norwegian trauma protocol in a cohort of severely injured patients at the University Hospital of North Norway, Tromsø. Hereby they were able to identify criteria that could result in overtriage. They concluded that several criteria should be removed; the most important ones in relation to our protocol are: motorcycle accident and considerable deformation of vehicle compartment. In our dataset, analysis of the individual criteria applied for TTA was not possible as these data were not registered before 1 March 2010. Caution is necessary when extrapolating conclusions as the populations are not fully identical, but the main characteristics and mechanisms of injury of the two studies are very similar.

The current trauma protocol utilizes a rating system that assigns points ranging from zero to two in seven organ- or anatomy-related categories (Table 1), a mix of subjective and objective findings. Additionally, a single point is given for at-risk patients (age or co-morbidity), yielding a maximum score of 15. In order to assess which criteria lead to unnecessary TTA and overtriage, a complete registration of each category for every patient is needed. These data should be a basis for further studies to improve the trauma protocol.Our hypothesis was that an MD-EMS highly trained in emergency medicine would be able to make more precise field triage of the trauma patients. This was not shown. One reason for this may be that the trauma protocol in part relies on objective findings, which, on the one hand, makes it easy to use, especially by EMS personnel. However, on the other hand, it leaves little room for professional evaluation by the MD-EMS. This rigidity may, in part, explain why the introduction of an MD-EMS apparently did not result in a reduction of over- or undertriage. It should be noted that, as a consequence of the retrospective design of our study, this argument is speculative. We were in no manner able to substantiate a positive effect of the MD-EMS to field trauma triage. The argument could be made that more than is presently the case, the pre-hospital visitation protocol could be designed to take advantage of the considerable expertise of the MD-EMS in reducing over- and undertriage. In a study of 2,221 severely injured patients, Rehn et al [15] reported 35% overtriage and 2% undertriage when triage was performed by anaesthetist-manned services. In the same study the EMS personnel achieved a 66% overtriage and 17% undertriage. These findings may be owed to a different set of triage criteria that rely more on subjective findings and thereby utilize the highly trained clinical eyes of the anaesthetist. Another reason for the lack of difference could be a problem in the visitation of the MD-EMS. If the MD-EMS were not directed to the most critically injured patients, any difference would be harder to register. Because of lack in registration it was not possible to analyse the difference between the MD-EMS and the EMS personnel regarding over- and undertriage; our numbers for the two groups were therefore pooled. This important area should be explored in future studies.

Over the past 10-15 years, numerous trauma centres have created a two-tiered triage and TTA protocol. The idea has been to separate patients with a high likelihood of serious injury and in need of immediate evaluation and treatment from those with a low likelihood of serious injury. Patients are either received by a full or a reduced trauma team. The effect on both overtriage and use of resources has been significant [16-18], without increasing mortality. To the best of our knowledge, such a system has not yet been implemented in Denmark. One way to decrease overtriage, other than redoing the TTA protocol, may be to implement of a two-tiered protocol. This would also lead to a more precise calculation of the resources saved by decreasing the overtriage, as it would be possible to estimate the cost of saved labour for the staff groups not activated. This could ideally be studied in a prospective cohort study performed at Viborg Regional Hospital.

Finally, our study clearly shows the need for a more

A physician-manned emergency medical service (MD-EMS) car from the Region of Central Jutland. Photo: the Region of Central Jutland.

detailed electronic registration of trauma patients and for a national registry. Currently, work is in progress both at a European level (EuroTARN, and at the Scandinavian level (Scandinavian Networking Group for Trauma and Emergency Management) to create and manage international databases. In the future, such data will be an important source for epidemiological and clinical research for trauma system design across Europe.

Limitations

A retrospective study has several limitations. There is a risk of incomplete data collection and retrospective bias. The patients' AIS scores were assessed manually by two doctors, which may give rise to inter-observer variability. Furthermore, each patient was only scored once. To accommodate this problem, initial meetings were held where a representative cohort of patients was scored double and the score compared with the AIS score. Still, as studies of the reliability of the AIS systems have shown [19], we must expect certain variability in AI scores.

Our estimate of undertriage is based on the assumption that any severely injured trauma patient will inevitably come into contact with either the ICU or the IMU. This may lead to an underestimation of undertriage as major traumas that undergo stabilization without the need for intensive care will not be included. In reality, this would probably rarely be the case. Nor will patients who are transferred to another trauma centre without assistance from the ICU. Lastly, the patients have been drawn from a registry of ICU patients which raises potential miscoding issues.

CONCLUSION

In conclusion, this study shows a high overtriage for the hospital's trauma calls and in the presented data material no difference in over- and undertriage was seen after implementation of physician-manned pre-hospital response. However, there is no clear-cut limit to which degree of overtriage is correct. This makes it difficult to assess a reasonable degree of mistriage, and it is ultimately up to the politicians to decide how health care expenditures are best prioritized. However, we can provide our best and most accurate data to support their decision-making. This is best done in regional or national trauma forums.

CORRESPONDENCE: *Lars Andreas Holm Burén,* Anæstesi- og operationsafdelingen, Regionshospitalet Viborg, Heibergs Allé 4, 8800 Viborg, Denmark. E-mail: labure@rm.dk

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