Evaluation of the performance of French physician-staffed emergency medical service in the triage of major trauma patients

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BACKGROUND: Proper prehospital triage of trauma patients is a cornerstone for the process of care of trauma patients. In France, emergency physicians perform this process according to a national triage algorithm called *Vittel Triage Criteria* (VTC), introduced in 2002 to help the triage decision-making process. The aim of this two-center study was to evaluate the performance of the triage process based on the VTC to identify major trauma patients in the Paris area.

METHODS: This was a retrospective analysis of two cohorts. The first cohort consisted of all patients admitted between January 2011 and September 2012 in two trauma referral centers in the region of Paris (*Ile de France*) and allowed estimation of overtriage. Undertriage was assessed in a second cohort made up of all prehospital trauma interventions from one emergency medicine sector during the same period. Adequate triage was defined by a direct admission of patients with an Injury Severity Score (ISS) greater than 15 into one of the regional trauma centers, and undertriage was defined as an initial nonadmission to a trauma center. Overtriage was defined by an admission of patients with an ISS of 15 or lower to a trauma center. The performance of the VTC was evaluated according to a strict to-the-letter application of the VTC and termed as *theoretical triage*. Logistic regression was performed to identify VTC criteria able to predict major trauma.

RESULTS: Among 998 admitted patients of the first cohort, 173 patients (17%) were excluded because they were not directly admitted in the first 24 hours. In the first cohort (n = 825), adequate triage was 58% and overtriage was 42%. In the second cohort (n = 190), adequate triage was 40%, overtriage was 60%, and undertriage was less than 1%. Theoretical triage generated a nonsignificantly lower overtriage and a higher undertriage compared with observed triage. The most powerful predictors of major trauma were paralysis (odds ratio [OR,] 0.09; 95% confidence interval [CI], 0.03–0.22), flail chest (OR, 0.1; 95% CI, 0.01–0.03), and Glasgow Coma Scale (GCS) score of less than 13 (OR, 0.28; 95% CI, 0.17–0.45), whereas global assessments of speed and mechanism alone were poor predictors (positive likelihood ratio, 0.92–1.4).

CONCLUSION: In the Paris area, the French physician-based prehospital triage system for patients with suspicion of major trauma showed a high rate of overtriage and a low rate of undertriage. Criteria of global assessment of speed and mechanism alone were poor predictors of major trauma. (*J Trauma Acute Care Surg*. 2014;76: 1476–1483. Copyright © 2014 by Lippincott Williams & Wilkins)

KEY WORDS: Triage process; prehospital care; undertriage; French system; algorithm.

The prehospital triage process is an essential element of any mature trauma system. The appropriate triage allows the trauma patient to be admitted to the most adapted care facility. This is decisive for major trauma (MT) patients since it is associated with a better outcome.[1] Besides, an appropriate prehospital triage process should also avoid excessive admission to specialized centers, that is, overtriage, to preserve proper allocation of care facilities and to save costs. Undertriage and overtriage are both important components to evaluate the maturity of a trauma management system, since they influence patient outcome and resource use. A large body of recent work performed on prehospital triage of MT in paramedic staffed

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trauma systems[2,3] using specific protocols[4] suggests that overtriage and undertriage are in concordance with existing recommendations. In France, the triage process is performed by a physician-staffed prehospital emergency medical system (EMS). The performance of this organization with respect to adequate triage remains unknown, and for physician-staffed systems in general, data are lacking.[5]

Therefore, the goal of the present study was to evaluate the performance of the triage process in the physician-staffed prehospital EMS in France based on a specific triage algorithm, the Vittel Triage Criteria (VTC),[6] from the perspective of two trauma centers in the Paris Region (*Ile de France*).

PATIENTS AND METHODS

Setting, Study Population, and Design

The study had two parts. The first part was conducted in all patients consecutively admitted to Beaujon and Bicêtre University trauma centers from January 1, 2010, to September 30, 2012. This Cohort I served to estimate overtriage.

The second part included all MT patients identified in the electronic database of the prehospital EMS (*Service d'Aide Médicale Urgente* [SAMU]) in the Northern prefecture 92 (*Hauts-De-Seine*) in the same study period. This Cohort II served to estimate undertriage.

The institutional review board (*Comité d'Ethique et d'Evaluation de la Recherche Biomédicale*, no. 11–115) approved the study.

EMS and Trauma Organization in the Region *Ile-de-France*

The *Ile de France* is the region around Paris city, with a population of approximately 12 million. This region is organized in seven prefectures. Each prefecture has one SAMU center responsible for the prehospital medical service, dealing with all major medical emergencies and MT in particular.

Emergency calls from bystanders are centralized to the telephone number "15." On the basis of the information provided by these calls, a 24/7 available dispatching physician decides which emergency vector, either a paramedic-staffed ambulance or physician-staffed mobile intensive care unit (*Service Mobile d'Urgence et de Réanimation* [SMUR]), is to be deployed. Paramedics in the region *Ile de France* are professional firemen (*Brigade des Sapeurs Pompiers* [BSPP]) and have a skill level that corresponds in the United States to an emergency medical technician basic level.

Usually, if an MT is suspected, an SMUR vehicle is deployed. After initial clinical evaluation, the physician on scene and the dispatching physician determine together the most adapted care facility. Concomitantly, the physician on scene initiates the prehospital resuscitation as needed. Introduced in 2002 by the *Société Française de Médecine d'Urgence* (SFMU), the VTC is taught to emergency physicians to guide the prehospital triage process (Fig. 1). The VTC provides a five-step evaluation of the situation including physiologic, anatomic, and resuscitation parameters as well as accident and mechanism criteria. The presence of one or more of the 26 criteria can justify direct admission to a trauma center.

For the first part of the study Beaujon and Bicêtre University hospitals were chosen. Both are two of the five so-called trauma centers in the region *Ile de France*. Beaujon is located in the north of the *Ile de France* and Bicêtre in the south (Fig. 2). According to administrative annual data (2013), they receive an average of 35% of all the MT patients of the *Ile de France* area (data not shown).

For the second part of the study, the northern part of the prefecture 92, *Hauts-De-Seine,* with a population of 600,000, was chosen. The geographic area covered by SAMU 92 is shown in Figure 2.

Data Collection

For Cohort I, data from all patients admitted to the trauma bay of Beaujon or Bicêtre University hospitals for suspicion of MT were retrospectively extracted from patient files. Since 2010, the clinical files of trauma patients were standardized in both hospitals to allow a reproducible and homogenous data collection including prehospital and hospital items.[7] The following prehospital items were recorded: age, sex, body mass index, type of trauma, worst systolic and diastolic arterial blood pressures, heart rate, worst peripheral oxygen saturation (SpO_2), Glasgow Coma Scale (GCS), clinical neurologic impairment, and care provided. The following items were collected on arrival at the hospital: systolic arterial pressure (SAP), heart rate, SpO_2, GCS, transfusion requirements (6 hours and 24 hours), treatment, basic laboratory parameters (blood count, hemostasis, biochemistry), and outcome. The following scores were calculated after anatomic and physiologic assessments had been completed: Abbreviated Injury Scale (AIS) score, Injury Severity Score (ISS),[8] and Simplified Acute Physiology Score (SAPS II).[9]

For Cohort II, all data were extracted from the electronic database of the SAMU 92. This database allowed tracing of all patients who required care by a physician-staffed mobile intensive care unit. This concerned also patients who required immediate physician-assisted evacuation from a peripheral hospital to a trauma center.

Definitions of Major Trauma

For both cohorts of the study, an ISS greater than 15 defined MT.

For Cohort I, admission of an MT patient to one of the two trauma centers was considered as adequate triage.[10,11] Overtriage was defined as an admission of patients with an ISS of 15 or lower to one of the two hospitals. Theoretical triage referred to the result of the virtual triage had the VTC been solely and strictly applied during prehospital assessment. As a consequence, theoretical undertriage referred to patients having no VTC and presenting with an ISS greater than 15.

For Cohort II, undertriage was defined as the admission of patients with an ISS greater than 15 to a nontrauma center. Admission to one of the five trauma centers of the region was considered as adequate triage.[10,11] Overtriage was defined as admission of patients with an ISS of 15 or lower to one of these five hospitals. Theoretical triage referred to the result of the virtual triage had the VTC been solely and strictly applied during prehospital assessment. As a consequence, theoretical undertriage referred to patients having no VTC and presenting with an ISS greater than 15.

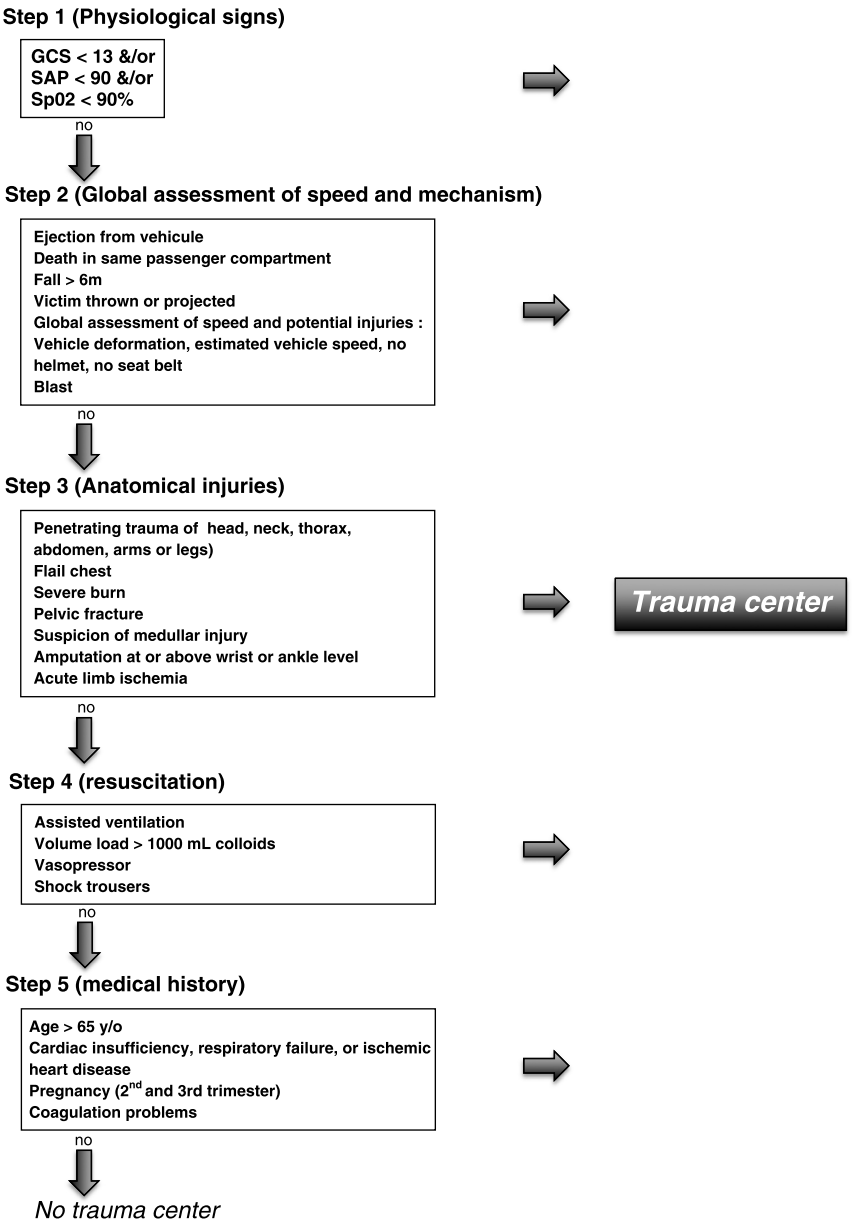

Figure 1. The Vittel Triage Criteria (VTC).

End Points

The primary end point in Cohort I was the rate of adequate triage. Secondary end points were overtriage, undertriage, and theoretical triage rates. The predictive performance of triage criteria was only assessed in the Cohort I. The primary end point in Cohort II was undertriage.

Statistical Analysis

Data were expressed as numbers and percentages or as means and standard deviations for normally distributed data or median with interquartile range [25–75 interquartile] for non-Gaussian data. Comparisons of nominal variables used a paired χ^2 test. Sensibility, specificity, positive predictive value, negative predictive value, and likelihood ratios were calculated for different items of the VTC. A multivariate logistic regression determined the strength of the association between the criteria and overtriage. Since this was an exploratory pilot study, to measure estimations of undertriage or overtriage, no baseline hypothesis could be established.

Statistical significance was set at the $p < 0.05$ level, and all statistical analyses were performed using Jump version 8 for Windows (SAS Institute Inc., Campus Drive, Cary, NC).

RESULTS

Cohort I, Estimation of Overtriage

From January 1, 2011, to September 30, 2012, 998 trauma patients were admitted to the two centers. A total of

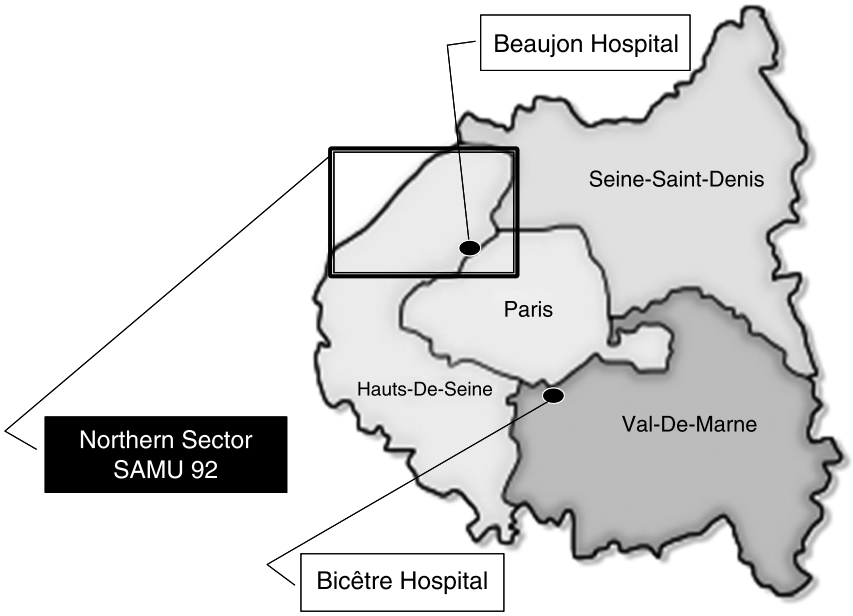

Figure 2. Map focused on the core of the *Ile de France* and situation of Beaujon and Bicêtre hospitals. Northern sector of the *Hauts-De-Seine* department (92) delimited by the *double-lined box*.

173 patients (17%) who had not been directly admitted within the first 24 hours after the accident were withdrawn from the analysis (flowchart displayed in Fig. 3), leaving 825 Cohort I patients (descriptive data in Table 1). In 478 cases (58%), triage was adequate with an ISS greater than 15 (Table 2). The rate of overtriage was 42% (n = 346). Undertriage could not be calculated in this cohort. Theoretical triage, meaning strict application of the VTC, would have resulted in a slightly lower overtriage of 36% (n = 297) and theoretical undertriage of 2% (n = 16). The difference between these two rates was not significant (Table 2).

A total of 1,922 criteria were present among all 825 and 742 patients (90.9%) presented at least one or more VTC (Table 4). Of the 83 patients admitted without any Vittel triage criterion, 17 (21%) had an ISS greater than 15.

The most frequently encountered criteria were global assessment of speed and mechanism (n = 354, 43.3%), mechanical ventilation (n = 288, 35.4%), GCS score of less than

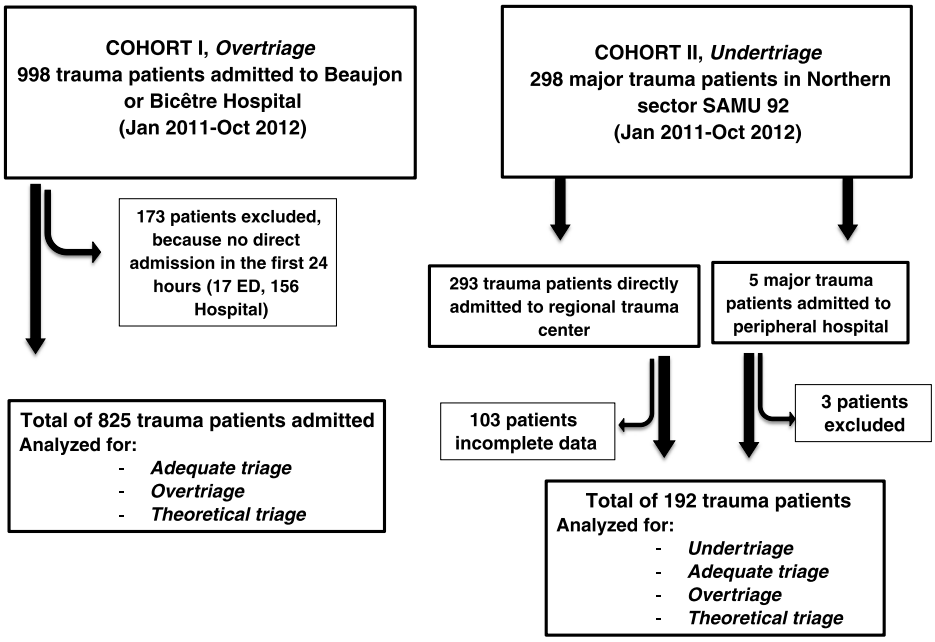

Figure 3. Flow chart of primary and subgroup analysis. *ED*, emergency department.

TABLE 1. Descriptive Data of the Cohort I and Cohort II

	Cohort I (n = 825)	Cohort II (n = 190)
Sex, male, n (%)	651 (79)	134 (71)
Age, mean (SD)	37 (17)	28 (15)
Patients ≥ 65 y, n (%)	66 (7.3)	10 (5)
ISS, median (IQR)	18 (9–29)	10 (4–19)
SAPS II, median (IQR)	22 (12–41)	13 (8–29)
Prehospital care, median (IQR), min	80 (59–107)	60 (45–75)
Mortality, n (%)	99 (12.9)	8 (4)
Intensive care unit length of stay, median (IQR), d	3 (1–8)	2 (1–4)
Mechanism of injury, n (%)		
Blunt and penetrating	767 (93.1); 58 (6.9)	176 (93); 13 (7)
Firearm	16 (2)	3 (2)
Stabbing	41 (5)	10 (5)
Pedestrian/cyclist	90 (11)	15 (8)
Car crash	156 (19)	29 (15)
Motorbike	232 (28)	70 (38)
Fall	231 (28)	49 (25)
Other	57 (7)	14 (7)

13 (n = 239, 29.3%), and hypotension of less than 90 mmHg (n = 165, 20%). Some criteria had a very low incidence, namely, burn, amputation, limb ischemia, use of shock trousers, and known medical history. Criteria that prevented overtriage and favored adequate triage (Table 4) were paralysis (odds ratio [OR], 0.09; 95% confidence interval [CI], 0.03–0.22), flail chest (OR, 0.1; 95% CI, 0.01–0.3), and GCS score of less than 13 (OR, 0.28; 95% CI, 0.17–0.45). The criteria "volume load" and "vasopressor use" were both never observed without association to other physiologic or anatomic criteria that suggested an MT. A triage decision based on "mechanical ventilation" as the only criterion with no other VTC criterion associated, generated overtriage in 100% of the cases (Tables 3 and 4).

Cohort II, Estimation of Undertriage

A total of 298 prehospital interventions for MT in the northern sector of the prefecture 92 could be identified from the database of the SAMU 92 from January 1, 2011, until September 30, 2012. Of these, 293 patients (98%) were directly admitted to one of the five *Ile de France* trauma centers. Of these 293 patients, data from a total of 190 patients (64%) were available to determine adequate triage (40%), overtriage (58%), theoretical overtriage (46%), and theoretical undertriage (1%) (Table 2).

The SAMU 92 database identified five MT patients who were initially admitted to the emergency department of a nontrauma center. Three of them had come on their own initiative to the emergency department hours after their trauma, so they had not been triaged. They were excluded from the analysis. The EMS was contacted for the remaining two patients, and they were taken to a nontrauma center emergency department. Concordantly, only these two patients could be considered as undertriaged. This corresponds to an undertriage rate of 2 of 295 (<1%).

These two patients were men, aged 59 and 79 years; the first fell in the stairs at home, and the second was involved in a traffic accident as pedestrian. On scene, both presented with a GCS score of 15 of 15 and no loss of consciousness. The hemodynamic situation was regarded as stable, although the older patient had an initial low systolic blood pressure of approximately 90 mmHg. None had tachycardia or tachypnea. The younger one experienced advanced cirrhosis; the older patient was treated with oral anticoagulants. In both cases, the initially stable situation evolved during the first hour in the peripheral nontrauma center emergency department into acute hemorrhage because of multiple lesions and then shock. Both required hemodynamic and hemostatic resuscitation with blood products and coagulation factors on arrival in a trauma room of a specialized center. A complete body computed tomographic scan demonstrated for the first patient complex facial fractures with acute hemorrhage and, for the second patient, brain hemorrhage and multiple bleeding soft tissue injuries. Both patients survived. Assessment according to the VTC would have revealed at least one criterion for both of them: age greater than 65 years, coagulation disorder, global assessment of speed (pedestrian hit by vehicle).

DISCUSSION

This is the first study designed to evaluate the performance of the triage process in a physician-staffed EMS in France. In a cohort of 825 patients, we have found an adequate triage rate of 58% and an overtriage rate of 42%. In a second cohort, undertriage in the evaluated EMS was less than 1%. These findings indicate that the triage process reported here is associated with a rather high overtriage and a particularly low undertriage rate. Exclusive application of the VTC seems to generate a lower rate of overtriage, although the difference was not significant.

Undertriage and overtriage are both important components to evaluate the maturity of a trauma system. Undertriage exposes the patients to a higher risk of mortality and morbidity particularly in the case of severe trauma and shock. Undertriage

TABLE 2. Absolute and Rate of Adequate Triage, Overtriage, Undertriage, and Theoretical Triage for Main and Subgroup Analysis

	Cohort I, n = 825	Cohort II, n = 190
Adequate triage, n (%)	478 (58)	76 (41)
Overtriage, n (%)	346 (42)	108 (57)
Undertriage, n (%)	—	2 (<1)
Theoretical overtriage, n (%)	297 (36)	87 (46)
Theoretical undertriage, n (%)	16 (2)	2 (1)

For Cohort I, adequate triage referred to the admission of an MT patient to one of the two trauma centers. Overtriage referred to the admission of patients with an ISS of 15 or lower to one of the two trauma centers.

For Cohort II, adequate triage referred to the admission of MT patients (ISS > 15) to any trauma center of the region. Undertriage referred to the admission of patients with an ISS greater than 15 to a nontrauma center. Overtriage referred to the admission of patients with an ISS of 15 or lower to any trauma center of the region.

Theoretical triage referred to the virtual triage had the VTC been solely and strictly applied during prehospital assessment. Theoretical overtriage referred to patients having at least one VTC and presenting with an ISS of 15 or lower. Theoretical undertriage referred to patients having no VTC and presenting with an ISS greater than 15.

TABLE 3. Predictive Performance of Isolated VTC

	n = 1,992	Sensitivity, %	Specificity, %	Positive Predictive Value, %	Negative Predictive Value, %	Positive Likelihood Ratio	Negative Likelihood Ratio
GCS score < 13	252	44	91	88	53	5	0.6
SAP < 90 mmHg	191	34	86	77	48	2.4	0.8
Spo_2 < 90%	70	16	94	79	44	2.6	0.9
Ejection from vehicle	51	49	50	58	41	1	1
Death in same passenger compartment	11	44	53	57	40	1	1
Fall > 6 m	130	67	36	60	43	1	0.9
Global assessment of speed and potential injuries*	372	67	27	57	37	0.9	1.2
Victim thrown or projected	93	13	93	72	43	1.8	0.9
Penetrating trauma	59	5	91	43	40	1.8	0.9
Flail chest	19	3	1	92	42	7.8	1
Pelvis fracture	118	18	92	77	44	2.4	0.9
Paralysis	47	8	99	90	43	6.2	0.9
Assisted ventilation	304	52	88	86	56	4.4	0.6
Volume load > 1,000-mL colloids	85	14	96	82	44	3.3	0.9
Vasopressor	130	24	97	91	47	7	0.8
Age > 65 y	58	8	95	70	42	1.6	1

Descriptive statistics were not assessed for burn (3), amputation (5), ischemia (3), antishock trousers (0), and for any element of known medical history (3).
*Vehicle deformation, vehicle estimated speed, no helmet, no seat belt.

should therefore be very low to avoid over mortality. Although overtriage may seem less critical, it should be minimized since it contributes to trauma bay overcrowding and decreases the overall efficiency of the system.[12] High levels of overtriage can lead to an inappropriate use of resources, increases avoidable expenditure, as well as the exposure to health care–associated risks such as irradiation.[13]

Although in accordance with current guidelines,[14] the observed rates of adequate triage and low undertriage seem to come at the expense of a comparatively high rate of overtriage in comparison with Anglo-Saxon EMS.[2,12,15,16] These data from Anglo-Saxon EMS suggest that overtriage is generally lower and undertriage is slightly higher.

TABLE 4. OR for Overtriage (ISS ≤ 15) From Nominal Logistic Regression for the Most Frequently Observed Vittel Criteria

	n = 1992	OR	95% CI
GCS score < 13	l252	0.28	0.17–0.45
SAP < 90 mmHg	191	0.73	0.45–1.16
Spo_2 < 90%	70	0.45	0.21–0.91
Ejection from vehicle	51	0.70	0.37–1.29
Death in same passenger compartment	11	0.92	0.23–3.59
Fall > 6 m	130	0.59	0.35–0.90
Global assessment of speed and potential injuries*	372	1.12	0.79–1.52
Victim thrown or projected	93	0.48	0.28–0.81
Penetrating trauma	59	1.02	0.56–1.86
Flail chest	19	0.10	0.01–0.03
Pelvis fracture	118	0.42	0.25–0.65
Paralysis	47	0.09	0.03–0.22
Assisted ventilation	304	0.33	0.21–0.52
Volume load > 1,000-mL colloids	85	0.54	0.29–0.97
Vasopressor	130	0.52	0.25–1.00
Age > 65 y	58	1.11	0.58–2.08

*Vehicle deformation, vehicle estimated speed, no helmet, no seat belt.

The present data may offer two explanations for this observation. First, the observed prehospital physicians seemed not to adhere systematically to the provided algorithm (VTC). Observed triage generated slightly higher overtriage than theoretical triage according to a to-the-letter application of the VTC. However, the difference was not significant, and the sample was too small to suggest an eventual impact on patient outcome if the VTC was strictly applied. In this respect, it is of note that the two undertriaged patients would have been identified by the VTC. In contrast, 17 patients (2%) had an ISS greater than 15 but presented without any VTC criterion. None of these were in shock and required urgent surgery, and only four were admitted to the intensive care unit.

Second, noncompliance with the VTC may express the observed physicians' confidence in their individual triage capacities. In consequence, they seemed to rely more likely on heuristic elements such as clinical gestalt[17,18] during prehospital triage. This interpretation is in accordance with a recent assessment of triage decision in the United States. The study suggested that the EMS provider's "gut feeling" or heuristics regardless of their background had the greatest influence on identifying seriously injured patients.[19] Alternatively, the high overtriage can also convey a higher risk aversion due to a lack of experience in some SMUR physicians. Major trauma represents only 30% of all SMUR activities in France.

With regard to individual items of the VTC, the present data confirm and extend[20] that without association with anatomic or physiologic criteria, the global assessments of speed and mechanism criteria alone are poor predictors of MT. This

information is often indirectly estimated by witness or patient testimony, skid marks, telemetry, and vehicle deformation and thus unreliable. A triage decision relying exclusively on injury mechanism alone probably leads to an increased overtriage rate.[2,20,21] VTC specific to the French concept of physician-staffed prehospital care are mechanical ventilation, volume load greater than 1,000-mL colloids, and vasopressor use. According to the presented results however, the additional value of these three criteria seems questionable.

Several limitations of this study have to be acknowledged. Although the definition of MT, as ISS greater than 15, seems to be the most widely accepted compromise, its inherent limitations are obvious.[22–25] A composite definition that takes into account additional surrogate markers such as airway need or hemorrhage control, organ dysfunction, or need for other specific trauma center resources[15,26,27] seems useful. The "classic" definition of ISS greater than 15 was chosen to allow comparison with preceding studies.

This is not a population-based study but an analysis of two cohorts of patients admitted to two trauma referral centers and from one EMS sector. Although both samples are representative of MTs observed in the Paris region, a selection bias cannot be excluded. Finally, discordant triage decisions between the on-scene physician and the SAMU dispatcher physician were not systematically captured. Prehospital providers were not systematically asked whether their decision making was influenced by awareness of the VTC.

It is most important to note that the observed undertriage rate is derived from a limited sample of one EMS sector. Since the SAMU/EMS in the Paris area do not all use the same dispatch center software and data exploitation system, exhaustive data retrieval for all EMS and emergency department is currently impossible. For this reason, it could only be estimated for the given sector. In consequence, it cannot be ruled out that undertriage is higher in other sectors. However, the authors are confident in the estimation of undertriage, since the triage process and EMS organization in other sectors and areas are identical. It can reasonably be speculated that our study is representative of other areas of the Paris *Ile de France* region and, perhaps, of any urban area in France.

CONCLUSION

This is the first study to evaluate the performance of the triage process and the accuracy of the VTC to identify MT patients in a physician-staffed regional EMS in a part of the Paris area in France. It demonstrated an acceptable rate of adequate triage, a relatively low undertriage, but high overtriage rate compared with trauma systems in other countries and the United States in particular. With regard to the VTC, physiologic and anatomic criteria seemed to be more accurate than global assessment of speed and mechanism or prehospital resuscitation measures to predict MT.

AUTHORSHIP

S.R.H. contributed to the study design, data collection, data analysis and interpretation, literature search, and writing. T.G. contributed to the study design, data collection, data analysis and interpretation, literature search, and writing. J.T. contributed to the data collection, analysis, and interpretation. A.H. contributed to data collection and critical revision. M.R. contributed to data interpretation and critical revision. J.M. contributed in the critical revision and writing. F.-X.D., J.D., and C.P.-B. contributed to the critical revision.

DISCLOSURE

The authors declare no conflicts of interest.

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