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French pre-hospital trauma triage criteria: Does the “pre-hospital resuscitation” criterion provide additional benefit in triage?

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cal service to a trauma center. Patients who met any of the field trauma triage criteria were considered “triage positive”. Hospital data was statistically linked to pre-hospital records. The primary outcome of defining a “major trauma patient” was Injury Severity Score (ISS) > 16.

RESULTS: There were a total of 200 injured patients evaluated over a 2 years period who met at least 1 triage criterion. The number of false positives was 64 patients (ISS < 16). The PPV was 68%. The sensitivity and the negative predictive value could not be evaluated in this study since it only included patients with positive Vittel criteria. The criterion of “PH resuscitation” was present for 64 patients (32%), but 10 of them had an ISS < 16. This was statistically significant in correlation with the severity of the trauma in univariate analysis (OR = 7.2; $P = 0.005$; 95%CI: 1.6-31.6). However, despite this correlation the overall PPV was not significantly increased by the use of the criterion “PH resuscitation” (68% vs 67.8%).

CONCLUSION: The criterion of “pre-hospital resuscitation” was statistically significant with the severity of the trauma, but did not increase the PPV. The use of “pre-hospital resuscitation” criterion could be re-considered if these results are confirmed by larger studies.

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Key words: Pre-hospital; Triage; Vittel criteria; Injury Severity Score; Trauma

Abstract

AIM: To evaluate the performance of the specific French Vittel “Pre-Hospital (PH) resuscitation” criteria in selecting polytrauma patients during the pre-hospital stage and its potential to increase the positive predictive value (PPV) of pre-hospital trauma triage.

METHODS: This was a monocentric prospective cohort study of injured adults transported by emergency medi-

Core tip: This is the first evaluation of French Vittel criteria for pre hospital triage of trauma. The results of this study suggest that the criteria are efficient to select the severe trauma patients during the pre-hospital stage [positive predictive value (PPV) of 68%]. The criterion “pre-hospital resuscitation” was significantly correlated with the severity of the trauma, but did not

increase the PPV. This criterion, which is the only difference between French and United States pH triage criteria, does not procure extra value and compromises potential comparisons with multinational cohort studies. The use of "pre-hospital resuscitation" criterion should be reevaluated if these results are confirmed by larger studies.

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INTRODUCTION

The ideal pre-hospital (PH) triage should optimize the resources in a trauma center or in local hospitals by restricting over- and undertriage scenarios, thereby limiting undue costs and unnecessary geographical constraints for patients and families. Since 1987, a regularly updated PH triage scheme has been prepared by the American College of Surgeons Committee on Trauma (ACSCOT)^[1]. This scheme includes mechanism of injuries and replaces previously ineffective scoring such as trauma score^[2,3], trauma triage rule^[4], CRAM scale^[5] and the PH index^[6].

French PH trauma triage criteria were developed during the 2002 Emergency Ambulance Service (SAMU) conference in Vittel (France), which addressed French specific PH care^[7]. Triage criteria are classified into 5 categories and each of the criteria is sufficient to define a severe trauma, indicating the transfer of the patient to a trauma center. The Vittel criteria are similar to the ACSCOT classification with an additional criterion: "PH resuscitation" which corresponds to the specific management provided by the PH emergency physician (PHEP).

This study aims at evaluating whether the "PH resuscitation" criterion increases the positive predictive value (PPV) of Vittel criteria for an adult population. The study hypothesis is that the PPV is not increased, considering that all of the PH resuscitation maneuvers would be based on vital signs criteria, which are already factored into the triage assessment.

MATERIALS AND METHODS

Study design

This monocentric study compares the PH Vittel criteria (Table 1) with 2 scores calculated at the end of the clinical assessment: the Injury Severity Score (ISS) and the Trauma Injury Severity Score (TRISS). Polytrauma was defined as an ISS > 16. The goal of the study was to evaluate the performance of Vittel criteria to select polytrauma patients during the pre-hospital stage and evaluate any additional benefit with the use of the specific criterion "PH resuscitation". The data was prospectively

Table 1 Vittel pre-hospital triage criteria¹

Steps	Severity criteria
1 Vital signs	Glasgow coma scale < 13 or Systolic blood pressure < 90 mmHg or Saturation O ₂ < 90%
2 Evidence of high-energy trauma	Ejection from automobile Death in same passenger compartment Falls > 6 m Victim thrown or crushed Global assessment of the trauma (aspect of the crashed vehicle, vehicle telemetry data consistent with high risk of injury, no motorcycle helmet, no seat belt) Blast
3 Anatomy of injury	Penetrating trauma of head, neck thorax, abdomen, pelvis, thigh, and arm Flail chest Severe burns, smoke inhalation Pelvic bone fracture Suspicion of medullar trauma Amputation proximal to wrist or ankle Acute ischemia of the limb
4 Pre-hospital resuscitation	Intubated and mechanically ventilated patients IV Fluids > 1000 mL (colloids) Catecholamine Anti-shock trousers inflated
5 Special patient or system considerations	Age > 65 yr Heart failure Respiratory failure Pregnancy > 12 wk

¹The patient is considered as a severe trauma if he met one of the listed criteria and transferred to a trauma center.

collected. The protocol was approved by the Institutional Review Board.

Patient selection

From December 2008 to January 2010, all trauma patients were evaluated by the emergency physician in the field. The number of positive Vittel criteria was determined from the trauma case history including the phone report to the emergency department (ED). Patients presenting with one positive Vittel criterion were transported to and managed in a well equipped trauma center with an emergency department, intensive care unit, interventional radiology, a burn unit, and multiple surgical specialties (digestive, orthopedics, urology, otorhinolaryngology, plastic/reconstructive, neurosurgery). The facility receives an annual patient population of 900000, primarily tourists as well as residents of suburban and rural neighborhoods.

Data collected

The pre-defined data sheet utilized was divided into 2 parts: (1) collected PH stage data: Glasgow coma scale, respiratory rate, blood pressure, heart rate, injury mechanism, time of management, Vittel criteria, resuscitation protocol (IV fluids, oral intubation, venous access, drugs); (2) collected ED data: vitals, resuscitation protocol, injury profile, surgery, interventional radiology, survey, cause of death. ISS and TRISS were calculated at patient discharge.

Table 2 Profile of injury

Mechanism	n (%)	
Motorcycle crash	105 (52.7)	
Car crash	37 (18.5)	
Fall	30 (15.8)	
Pedestrian vs auto	16 (8)	
Gunshot wound	5 (2.5)	
Stab wound	2 (1)	
Other	4 (2)	
Anatomy of injury	Total n (%)	Hemorrhagic group n (%)
Number	200	33 (16.5)
Extremity		
Upper	60 (30)	8 (24)
Lower	53 (26.5)	9 (28)
Thorax		
Lung trauma	39 (19.5)	3 (9)
Pneumothorax	29 (14.5)	4 (12)
Hemothorax	21 (10.5)	14 (42.5)
Head	97 (48.5)	14 (42.5)
Face	39 (19.5)	4 (12)
Spine		
Stable	29 (14.5)	4 (12)
Unstable	8 (4)	0
Pelvic bone		
Stable	26 (13)	4 (12)
Unstable	10 (5)	6 (18)
Abdomen		
Hemoperitoneum	31 (15.5)	17 (51.5)
Hemoretroperitoneum	13 (6.5)	6 (18)
Pneumoperitoneum	3 (1.5)	1 (3)
Other	3 (1.5)	1 (3)

Statistical analysis

A statistical analysis evaluated the performance of the Vittel criteria in selecting patients with an ISS > 16 (Stata version 9 software, Stata Corporation). A descriptive analysis with the comparison between the subgroups was made with ANOVA. The correlation between the variables utilized the Pearson coefficient. Linear regression, univariate and multivariate analysis were used to measure the link between Vittel criteria and the ISS and TRISS. The significance level of the study was III.

RESULTS

Population

Two hundred trauma patients (using Vittel criteria) were included. Characteristics and profiles of injuries are described in Table 2. The median age was 40.4 years (with range of 16-96 years) and 78.5% of patients were male. All traumas were high energy (road trauma 71%, serious falls 15%). The median values of ISS and TRISS were respectively 22 (1-75, EC = 16.1) and 95.8% (2-99, EC = 29). As expected, the 2 scores had a high inverse correlation ($\rho = -0.77$). Forty-four percent of patients were hemodynamically unstable, 48.5% had limb trauma, head trauma 48.5%, and thoracic trauma 44.5%. The most common injury involved trauma of the extremities (48.5%), then head trauma (48.5%), and thoracic trauma (44.5%). The severity of trauma did not vary with gender.

Table 3 Correlation between the severity of trauma¹ and positive Vittel criteria

Vittel Criteria	Univariate analysis			Multivariate analysis		
	OR	P	95%CI	OR	P	95%CI
Vital signs	2.8	0.002	1.4-5.3	2.4	0.04	1.0-5.7
Evidence of high-energy trauma	1	0.8	0.5- 2.4	1.2	0.64	0.5-3.1
Anatomy of injury	0.6	0.2	0.2-1.4	0.5	0.21	0.2-1.5
Pre-hospital resuscitation	2.6	0.005	1.3-5.0	1.8	0.18	0.7-4.4
Special patient or system considerations	7.2	0.009	1.6-31.6	9.2	0.004	2.0-41.9

¹ISS > 16.

The elderly patients had a lower TRISS ($P = 0.002$) but with an unchanged ISS ($P = 0.118$). No mechanism was associated with a high ISS. Gunshot-penetrating trauma could be associated with a lower TRISS ($P = 0.06$).

PH stage

All patients were managed by a PHEP on the field. The median PH duration was 64.9 min (DS = 41.7 min, 15-240). This duration was associated with a lower TRISS ($P = 0.015$) but not with a higher ISS ($P = 0.075$). The first PHEP clinical report by phone and the first ED categorization of the patient were highly correlated ($P = 0.88$).

Analysis of the Vittel criteria

The number of false positives was 64 patients (ISS < 16 and at least one positive Vittel criteria). The PPV was 68%. The PPV was not significantly increased with the use of the criterion “PH resuscitation” (68% vs 67.8%). The sensitivity and the negative predictive value could not be evaluated in this study since it only included patients with positive Vittel criteria.

The distribution of the Vittel criteria is depicted in Figure 1. The most frequent criteria were “high energy trauma” (84.5%), and “physiological variables” (37%). Forty-eight percent of the patients had only one positive criterion; 23%, 23.5% and 3% had respectively 2, 3 and 4 positive criteria. No patient had 5 positive criteria.

The correlation between the positive Vittel criteria and the severity is detailed in Table 3. In univariate analysis, 3 criteria were associated with severity: “Vital signs” (OR = 2.8; $P = 0.002$; 95%CI: 1.4-5.3), “PH resuscitation” (OR = 7.2; $P = 0.005$; 95%CI: 1.6-31.6), and “Special patient or system consideration” (OR = 7.2; $P = 0.009$; OR = 1.6-31.6). In multivariate analysis, 2 criteria were associated with the severity: “vital signs” (OR = 2.4; $P = 0.04$; 95%CI: 1.0-5.7) and “Special patient or system consideration” (OR = 9.2; $P = 0.004$; 95%CI: 2.0-41.9). For the entire cohort: The more a patient had positive criteria, the more severe the trauma ($P < 0.0001$) and the more the patient needed emergency surgery (not statistically significant). For the group of “hemorrhagic patients”: the more a patient had positive criteria, the more severe the trauma (not statistically significant) and the more the patient needed an emer-

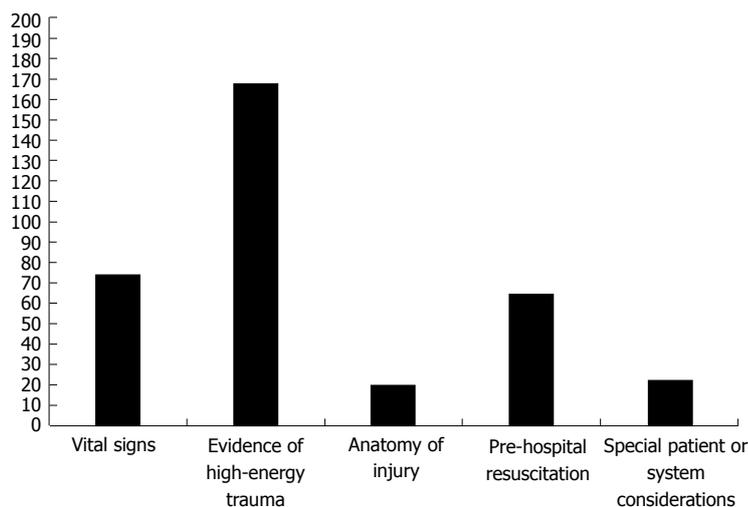


Figure 1 Distribution of positive Vittel criteria.

gency surgery (significant with regression analysis).

DISCUSSION

This study was intended to evaluate if the “PH resuscitation” criterion increases the PPV of Vittel criteria for an adult population. The study hypothesis was that the PPV is not increased, considering that all of the PH resuscitation maneuvers would presumably be based on vital sign criteria, which would then already be factored into the triage assessment. The results suggest that the French Vittel criteria are effective in selecting polytrauma patients (ISS > 16) with a PPV of 68%. The criterion of “PH resuscitation” does not improve the performance of the Vittel criteria.

Definition

There is no consensus for the definition of polytrauma; many definitions have been used: ISS > 16^[8,12], ISS > 20^[13], ISS > 16 associated with hospital length^[14], ISS associated with resources used^[8,15,16]. Other studies define polytrauma depending on the resources used^[4,17-20]. In this study we used the definition of the ACSCOT (ISS > 16). This definition optimizes the cost/efficiency ratio of the trauma centers^[21].

Overall Vittel criteria performance

In Westernized countries, severe trauma patients are usually identified during the PH stage by triage criteria as the “ACSCOT field triage decision scheme”, the last version published in 2006. Many studies have since been published to evaluate the triage criteria, with varying results^[8,21-25]. In 2011, Newgard *et al*^[23] published a major study about pre-hospital triage. In the study, 122345 patients were included and 7100 (5.8%) had an ISS > 16. The pre-hospital triage was done by the paramedics using the ACSCOT scheme. The sensitivity was 85% for all patients and 79% for patients over 55 years of age. The specificity was 68.7% for all the patients and 75.4%

for patients older than 55 years. The PPV to identify major trauma patients was 71.1%.

In France, the PH management of a trauma patient is performed by a mobile team including a PHEP. PHEP field management includes Cardio Pulmonary resuscitation with oral intubation, PRBC transfusion, chest tube, central venous access, and/or Fast Assessment Sonogram for Trauma exam. Therefore, specific criteria for pre-hospital triage have been published in 2002 during the SAMU conference in Vitel^[7] and are summarized in table 1. These are very similar to those of the ACSCOT, but also include the additional criterion of “PH resuscitation”. As expected, the performance of the Vittel criteria to identify polytrauma is very similar to the ACSCOT score (PPV: 68% *vs* 71.1%).

Performance of the criterion “PH resuscitation”

In this study, the criterion “PH resuscitation” was met by 64 patients (32%) but 10 of them had an ISS < 16. The false positive rate was 15%. This was significantly correlated with the severity of the trauma in univariate analysis (OR = 7.2; $P = 0.005$; 95%CI: 1.6-31.6). However, despite this correlation, the overall PPV was not significantly increased by the use of the criterion “PH resuscitation” (68% *vs* 67.8%)

Performance of the other criteria

Criterion “Vital signs”: In this study, the criterion “Vital signs” was significantly associated with the severity of the trauma in univariate analysis (OR = 2.8; $P = 0.002$; 95%CI: 1.4-5.3) and multivariate analysis (OR = 2.4; $P = 0.04$; 95%CI: 1.0-5.7). The effectiveness of this criterion was already discovered by Wuerz *et al*^[24], in 1996, with a low sensitivity (56%) but a high specificity (86%). This was associated with 20% mortality rate in the study published in 2005 by Hannan *et al*^[26].

Criterion “evidence of high-energy trauma”: In this study, the criterion “evidence of high-energy trauma” was not correlated with the severity of the trauma in the uni-

variate or multivariate analysis. Many studies have already shown that the mechanism of trauma is not associated with the severity of trauma^[10,13,27,28]. In a study published in 1986, Lowe *et al.*^[27] found an overtriage rate ranging from 14% to 43% in a cohort of 631 patients. This trend was corroborated in 2003 by Santaniello *et al.*^[28]. In a series of 830 patients, only 50% of the patients sorted by this criterion required surgery or an ICU admission. This criterion presents an element of sensitivity for the PH triage.

Criterion “anatomy of injury”: In this study, the criterion ‘anatomy of injury’ was not correlated with the severity of the trauma. Few studies have specifically analyzed this criterion: in 1995 Cooper *et al.*^[8] found a sensitivity of 40% with a PPV of 22%.

Criterion “Special patient or system considerations”: Within the study the criterion “Special patient or system considerations” was significantly associated with the severity of the trauma in univariate analysis (OR = 7.2; $P = 0.009$; 95%CI: 1.6-31.6) and multivariate analysis (OR = 9.2; $P = 0.004$; 95%CI: 2.0-41.9), but an accurate analysis of this criterion is difficult due to its variability (its contents being extremely PHEP dependent). It is however interesting to notice, that the specificity of the triage was higher for the patient older than 55 years (75.4% *vs* 64.3%) in the study of the ACSCOT^[23].

Limitations

The limitations of this study include a lack of statistical power due to the small cohort size. Also, we only included patients with one or more positive Vittel criteria, therefore we could not adequately assess the sensitivity of the criteria, which is the largest limitation. In addition, while the number of positive criteria was significantly associated with the severity of the trauma, this relationship did not exist with the subgroup “hemorrhagic patients” despite a hemorrhagic lesion being a severity factor in trauma, as shown by the higher need of emergency surgery. This paradox is probably due to a lack of statistical power due to the small cohort of hemorrhagic patients ($n = 33$). A larger study size is needed.

Overall, the results of this study indicate that the French Vittel criteria are efficient in selecting severe trauma patients during the pre-hospital stage, with a PPV of 68%. The criterion “pre-hospital resuscitation” was significantly correlated with the severity of the trauma, but did not increase the PPV. This criterion, which is the only difference between the French and the United States PH triage criteria, does not provide any added benefit, and actually compromises potential comparisons with multinational cohort studies. The use of “pre-hospital resuscitation” criterion should be re-evaluated if these results are confirmed by larger studies.

COMMENTS

Background

A pre-hospital (PH) triage is performed to optimize the resources in a trauma

center or in local hospitals by restricting over- and undertriage scenarios. Since 1987, a regularly updated PH triage scheme has been prepared by the American College of Surgeons Committee on Trauma (ACSCOT). This scheme includes mechanism of injuries. French PH trauma triage criteria were developed in 2002. They are similar to the ACSCOT classification with an additional criterion: “PH resuscitation” which corresponds to the specific management provided by the PH emergency physician.

Innovations and breakthroughs

This article is the first evaluation of the French triage criteria. They are no related or similar studies. A larger study will be performed by the emergency health service in Paris in 2015.

Applications

The results of this study indicate that the French Vittel criteria are efficient in selecting severe trauma patients during the pre-hospital stage, with a PPV of 68% but the criterion “pre-hospital resuscitation” did not increase the PPV. This criterion does not provide any added benefit, and actually compromises potential comparisons with multinational studies. This study is a clear advocacy for reconsidering the use this criterion if these results are confirmed by larger studies.

Peer review

The authors performed a monocentric prospective cohort study of injured adults to evaluate the performance of the French Vittel criteria to select polytrauma patients during pre-hospital stage and evaluate if their pre hospital resuscitation criterion increases positive predictive value of pre-hospital trauma triage.

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- 3 **Tian D**, Araki H, Stahl E, Bergelson J, Kreitman M. Signature

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- 5 **Vallancien G**, Emberton M, Harving N, van Moorselaar RJ; Alf-One Study Group. Sexual dysfunction in 1, 274 European men suffering from lower urinary tract symptoms. *J Urol* 2003; **169**: 2257-2261 [PMID: 12771764 DOI:10.1097/01.ju.0000067940.76090.73]

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- 6 21st century heart solution may have a sting in the tail. *BMJ* 2002; **325**: 184 [PMID: 12142303 DOI:10.1136/bmj.325.7357.184]

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- 9 Outreach: Bringing HIV-positive individuals into care. *HRS-A Careaction* 2002; 1-6 [PMID: 12154804]

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- 10 **Sherlock S**, Dooley J. Diseases of the liver and biliary system. 9th ed. Oxford: Blackwell Sci Pub, 1993: 258-296

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- 11 **Lam SK**. Academic investigator's perspectives of medical treatment for peptic ulcer. In: Swabb EA, Azabo S. Ulcer disease: investigation and basis for therapy. New York: Marcel Dekker, 1991: 431-450

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- 12 **Breedlove GK**, Schorfheide AM. Adolescent pregnancy. 2nd ed. Wicczorek RR, editor. White Plains (NY): March of Dimes Education Services, 2001: 20-34

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- 13 **Harnden P**, Joffe JK, Jones WG, editors. Germ cell tumours V. Proceedings of the 5th Germ cell tumours Conference; 2001 Sep 13-15; Leeds, UK. New York: Springer, 2002: 30-56

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- 14 **Christensen S**, Oppacher F. An analysis of Koza's computational effort statistic for genetic programming. In: Foster JA, Lutton E, Miller J, Ryan C, Tettamanzi AG, editors. Genetic programming. EuroGP 2002: Proceedings of the 5th European Conference on Genetic Programming; 2002 Apr 3-5; Kinsdale, Ireland. Berlin: Springer, 2002: 182-191

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- 15 Morse SS. Factors in the emergence of infectious diseases. Emerg Infect Dis serial online, 1995-01-03, cited 1996-06-05; 1(1): 24 screens. Available from: URL: <http://www.cdc.gov/ncidod/eid/index.htm>

Patent (list all authors)

- 16 **Pagedas AC**, inventor; Ancel Surgical R&D Inc., assignee. Flexible endoscopic grasping and cutting device and positioning tool assembly. United States patent US 20020103498. 2002 Aug 1

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