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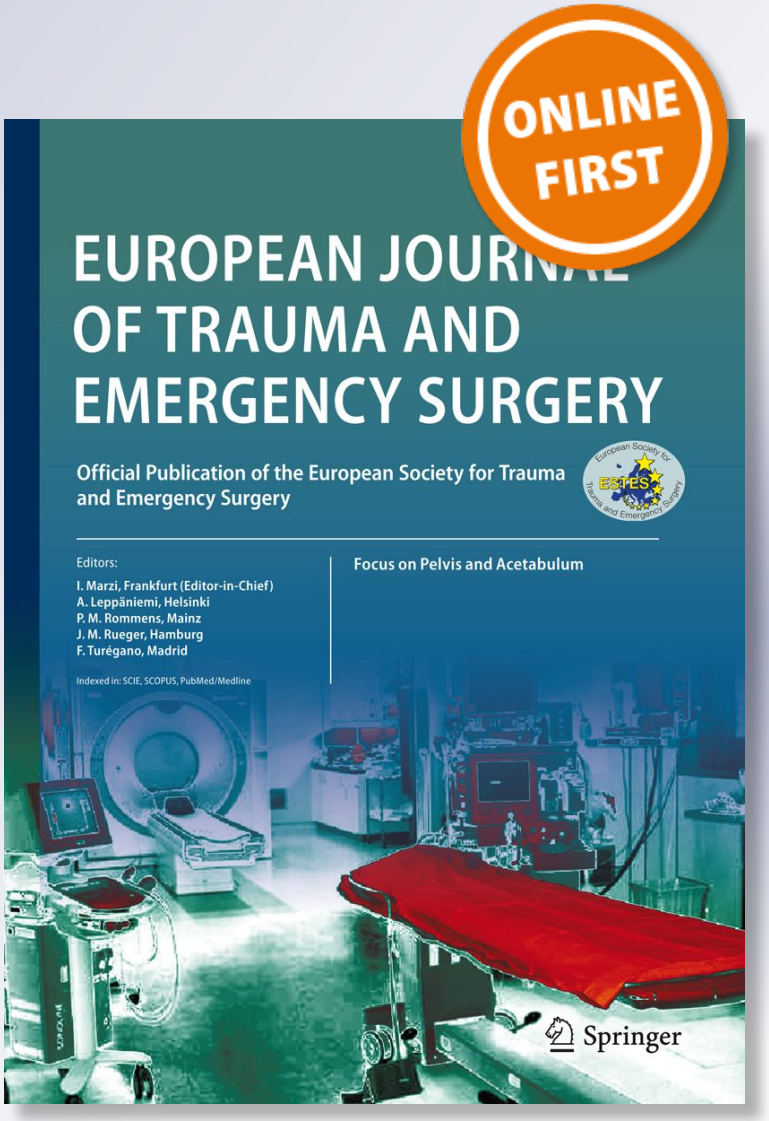


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ORIGINAL ARTICLE

# Prehospital triage for mass casualty incidents using the META method for early surgical assessment: retrospective validation of a hospital trauma registry

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## Abstract

**Background** In mass casualty incidents (MCI), death usually occurs within the first few hours and thus early transfer to a trauma centre can be crucial in selected cases. However, most triage systems designed to prioritize the transfer to hospital of these patients do not assess the need for surgery, in part due to inconclusive evidence regarding the value of such an assessment. Therefore, the aim of the present study was to evaluate the capacity of a new triage system—the Prehospital Advanced Triage Method (META)—to identify victims who could benefit from urgent surgical assessment in case of MCI.

**Methods** Retrospective, descriptive, observational study of a multipurpose cohort of patients included in the severe trauma registry of the Gregorio Marañón University General Hospital (Spain) between June 1993 and December 2011. All data were prospectively evaluated. All patients were evaluated with the META system to determine whether they met the criteria for urgent transfer. The META defines patients in need of urgent surgical assessment: (a) All penetrating injuries to head, neck, torso and extremities proximal to elbow or knee, (b) Open pelvic fracture, (c) Closed pelvic fracture with mechanical or haemodynamic instability and (d) Blunt torso trauma with haemodynamic instability. Patients who fulfilled these criteria were designated as "Urgent Evacuation for Surgical Assessment" (UESA) cases; all other cases were designated as non-UESA. The following variables were assessed: patient status at the scene; severity scales [RTS, Shock index, MGAP (Mechanism, Glasgow coma scale, Age, pressure), GCS]; need for surgery and/or interventional procedure to control bleeding (UESA); and mortality. The two groups (UESA vs. non-UESA) were then compared.

**Results** A total of 1882 cases from the database were included in the study. Mean age was 39.2 years and most (77%) patients were male. UESA patients presented significantly worse on-scene hemodynamic parameters (systolic blood pressure and heart rate) and greater injury severity (RTS, shock index, and MGAP scales). No differences were observed for respiratory rate, need for orotracheal intubation, or GCS scores. The anatomical injuries of patients in the UESA group were less severe but these patients had a greater need for urgent surgery and higher mortality rates.

**Conclusion** These findings suggest that the META triage classification system could be beneficial to help identify patients with severe trauma and/or in need of urgent surgical assessment at the scene of injury in case of MCI. These findings demonstrate that, in this cohort, the META fulfils the purpose for which it was designed.

**Keywords** Mass casualty incidents · Triage · Prehospital Trauma care · Surgical assesment · Trauma scores

## Background

In mass casualty incidents (MCI), the likelihood of death among severely injured patients depends on the characteristics of the accident [1] and the injury pattern [2]. Depending on the type and extent of the injuries, some patients would benefit from early transfer to a trauma centre [3]. Although most guidelines recommend the use of basic triage methods in MCIs, more advanced triage techniques (including

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severity scores) should be applied to prioritise care and transport to the hospital [4]. Most basic triage systems have been validated through scenario-based simulations and daily trauma patients, which provide data on the sensitivity and specificity of these systems [5, 6]. The available evidence on the value of existing triage systems is inconclusive [7], partly due to a lack of studies in real incidents [8]. Traditional MCI triage systems like START have shown some kind of undertriage in severe surgical patients [9]. An important aspect to consider in MCI triage methods is early detection of critically ill patients that could benefit from rapid transport to a surgical facility, instead of delaying transport due to overwhelmed resources. This approach could improve mortality rates in severe surgical patients in case of MCI, as described in the Barcelona terrorist attacks, were the META triage system was used according to Barcelona´s EMS [10].

Research has shown that the use of multiple triage systems in different settings, even by the same emergency medical services (EMS) team, can worsen the patient's prognosis. For this reason, the ideal approach would be to use the triage system that is best suited to the specific incident [11]. Importantly, none of the existing prehospital triage systems specifically designed for MCIs analyses the need for urgent surgery [12], even though most trauma-related deaths occur in the prehospital phase or within a few hours of arrival at the hospital.

Due to the large variability in the types of emergency cases, differences between EMS services and hospitals, and the difficult of establishing uniform prioritization criteria, new triage systems designed to improve care at the scene of injury are urgently needed [13]. To this end, in 2016 our group developed a new triage model for MCIs called META (for Modelo Extrahospitalario de Triage Avanzado—Prehospital Advanced Triage Method) based in advanced trauma life support (ATLS) protocols, anatomical injuries, and mechanism of injury. It is structured in four stages with rapid identification of severe trauma patients that could benefit from rapid transport to a surgical facility, and introducing a new patient flow that bypasses advanced prehospital medical post to improve evacuation. The four stages are: (1) Stabilization triage, to stablish treatment priorities, (2) is urgent surgical care needed?, to detect potential patients in need of an urgent surgical evaluation at a surgical facility, and creating a new high-priority flow of patients to be quickly evacuated, (3) advanced trauma life support protocols according to the established priority, and (4) evacuation triage, to establish evacuation priorities if needed (Fig. 1). The META, as compared to other MCI triage system like START, has demonstrated that it may improve prehospital times and the order of evacuation of patients, particularly those in need of immediate medical care or urgent surgery, with better rates of appropriate treatment in MCI [14].

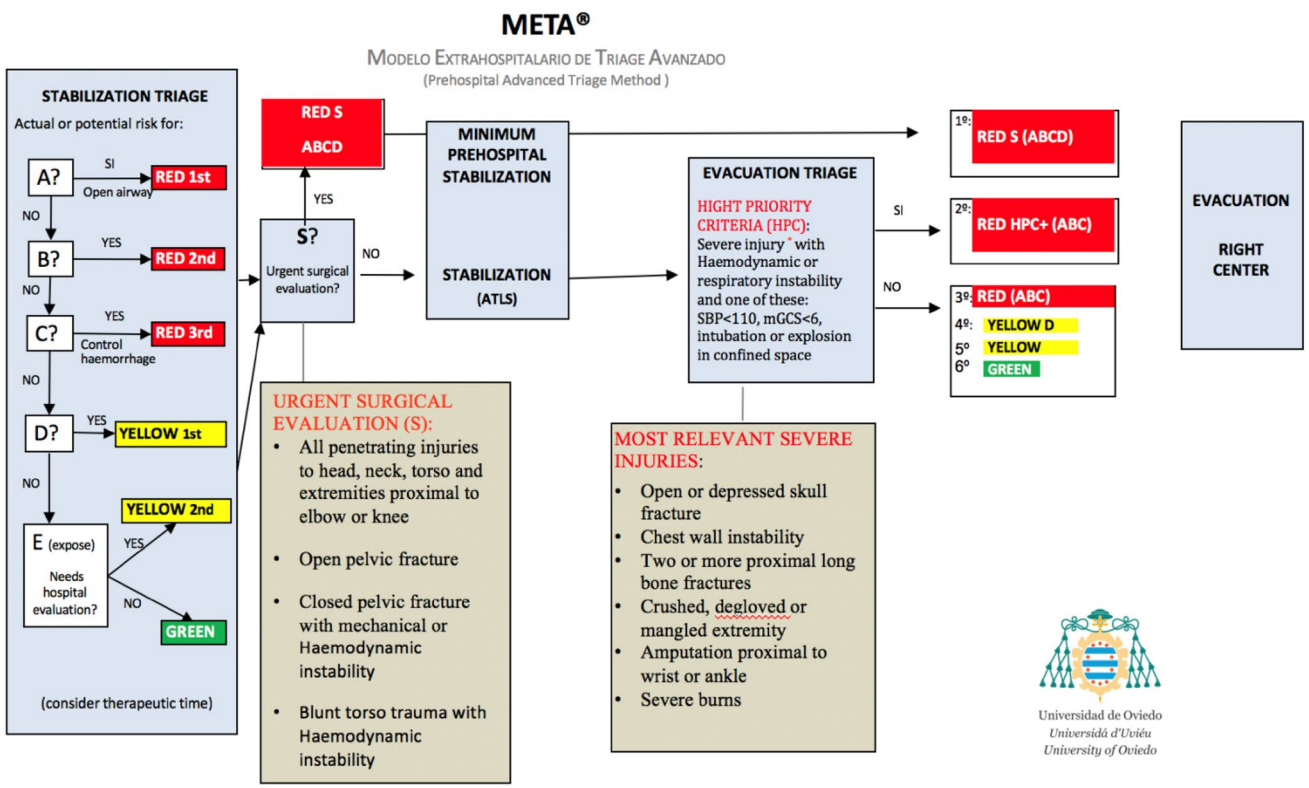


**Fig. 1** Meta triage system

In this context, the main objective of the present study was to retrospectively apply the META criteria to a large series of patients included in a hospital trauma registry, to identify the clinical characteristics of the patients requiring urgent surgical assessment. We hypothesized that this prehospital triage method would allow for a more precise identification of those casualties in need of urgent transfer for surgical assessment.

## Methods

This was a retrospective, descriptive, observational study with prospective analysis of a multipurpose cohort of patients included in the severe trauma registry (STR) at the Gregorio Marañón University General Hospital (GMUGH) between June 1993 and December 2011. The GMUGH is a level I trauma centre located in the metropolitan area of the Autonomous Community of Madrid. Data on prehospital care were obtained from the EMS reports. Data regarding the treatment and clinical course of patients during hospitalization were obtained from the clinical records and reports by the Emergency and Inpatient Departments.

The patient sample was obtained from the STR of the GMUGH in Madrid, Spain. Cases are included in this STR following the recommendations of the Center for Disease Control (CDC), as follows: (a) involvement of two anatomical regions; (b) injury to an anatomical area and a long bone fracture; (c) two or more long bone fractures; (d) any isolated, serious injury; or (e) any penetrating injury. The STR did not have any specific exclusion criteria.

The META classifies patients as needing "Urgent Evacuation for Surgical Assessment" (UESA) if they meet any of the following criteria: (a) penetrating injuries to the head, neck, torso and limbs proximal to the elbow or knee; (b) open pelvic injuries, (c) blunt pelvic fracture with mechanical or hemodynamic instability and/or (d) blunt torso trauma with hemodynamic instability [15]. Hemodynamic instability (HI) has been defined as a systolic blood pressure (SBP) < 90 mmHg, although a low SBP could be a late sign of shock in some cases [16]. Some authors recommend using a cut-off of 110 mmHg to define hypotension for both blunt and penetrating trauma [17]. The prehospital time is calculated as the time elapsed from the time the EMS arrives at the scene until the patient reaches the hospital; therefore, the time at the scene is included in this variable.

In accordance with current recommendations for assessing trauma mortality rates, patients considered "dead-on-arrival" (DOA) were those who: (a) arrive at the emergency department (ED) without signs of life and receive cardiopulmonary resuscitation (CPR) without any invasive manoeuvres other than continued CPR for a period of time based on information provided by the EMS [18]; or (b) arriving without signs of life or "in extremis" and receive CPR and invasive manoeuvres such as orotracheal intubation, chest tubes, emergency room thoracotomy, or blood transfusion [19].

The following patient data were collected: date of incident; age; sex; mechanism or type of trauma (i.e., blunt or penetrating); location of injury (AIS-85); vital signs on arrival, including: SBP, diastolic blood pressure (DBP), respiratory rate (RR), and heart rate (HR); physiological severity scores at the scene: Glasgow coma scale (GCS); revised Trauma Score (RTS); shock index (SI); MGAP (mechanism, GCS, age, pressure); META score [15], and Injury Severity Score (ISS). Patients diagnosed with a blunt pelvic fracture with mechanical instability were excluded from the study based on evidence indicating that the initial clinical diagnosis in such cases is often unreliable [20]. The need for CPR and/or intubation was included as part of the procedures and techniques performed during prehospital care, as was the prehospital time to the hospital. Other variables included: need for surgical intervention, interventional radiology procedures, and in-hospital mortality.

In the descriptive analysis, absolute ($n$) and relative frequencies (%) were used to describe qualitative variables while quantitative variables were expressed as means with standard deviation (SD) or medians with interquartile range [IQR]. Kolmogorov–Smirnov tests were used to assess the distribution normality of the study groups. The Chi-squared test or Fisher's exact test, as appropriate, were used to determine the significance of differences between variables. Statistical significance was set at $p < 0.05$. Statistical analyses were performed using the SPSS statistical software, version 22.0 (SPSS Statistics for Windows, IBM Corporation, Armonk, NY, USA). The study was approved by the Research Ethics Committee of the GMUGH.

## Results

A total of 1973 patients were included in the STR-GMUGH between June 1993 and December 2011. Of these, 91 were excluded from this study due to missing or invalid data in the EMS reports. Thus, the final sample included 1882 patients (Fig. 2). The median age of the sample was 35 [25] years. Most patients (77%) were male. The trauma type and frequency are provided in Table 1. The most common causes of trauma were as follows: motor vehicle collisions (MVC), stab wounds, and pedestrian injuries. Most patients ($n = 1767$; 93.9%) had injuries to more than one anatomical area, most commonly the thorax, the extremities, and the abdomen (Table 2).

Table 3 presents the patients' clinical variables and physiological severity scores at the scene of the incident. Upon arrival of the EMS, 66 (3.4%) patients required CPR

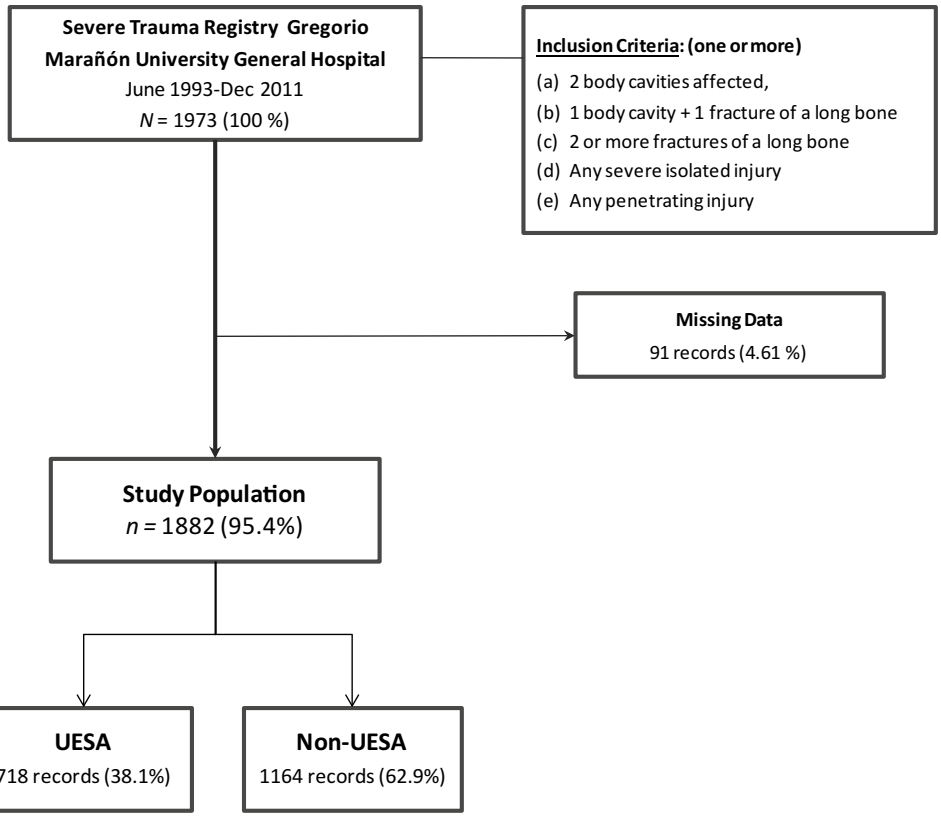


**Fig. 2** Flow sheet for patient inclusion. *UESA* urgent evacuation for surgical assessment, *Non-UESA* all other patients

**Table 1** Distribution of cases according to trauma mechanism

| Blunt | *n* (%) | Penetrating | *n* (%) |
|---|---|---|---|
| Car | 465 (32.9) | Stab wound | 373 (80.4) |
| Motorcycle | 230 (16.4) | Firearm injury | 83 (17.8) |
| Pedestrian injury | 280 (19.9) | Other | 8 (1.8) |
| Fall | 272 (19.4) | | |
| Other | 164 (11.4) | | |
| Total | 1418 (75.4) | Total | 464 (24.6) |

**Table 2** Localization of the trauma by anatomical area (AIS-85)

| Anatomic area | *n* (%) |
|---|---|
| Head and neck | 671 (35.7) |
| Face | 342 (20.0) |
| Chest | 1124 (60.3) |
| Abdomen | 795 (41.7) |
| Extremities | 953 (50.7) |
| Soft tissues | 615 (34.2) |

and 561 (29.8%) were intubated. The median prehospital time was 48 [26] minutes. Surgery and/or an interventional radiology procedure were carried out at the hospital in 1387 (73.7%) cases. The median ISS of the patients was 18.0 [16.3]. The median ICU stay was 5.0 [11.0] days.

**Table 3** Parameters and physiological scales of the patient at the scene

| | Mean ± SD | Median [IQR] | Max. | Min. |
|---|---|---|---|---|
| SBP (mmHg) | 114.4 ± 31.6 | 120.0 [30.0] | 220 | 20 |
| HR (bpm) | 94.2 ± 24.7 | 92.0 [30.0] | 236 | 20 |
| RR (rpm) | 17.5 ± 7.9 | 18.0 [5.0] | 60 | 5 |
| RTS | 10.4 ± 2.8 | 12.0 [2.0] | 12 | 0 |
| MGAP | 22.8 ± 5.1 | 24.0 [7.0] | 29 | 6 |
| GCS | 11.9 ± 4.6 | 15.0 [6.0] | 15 | 3 |
| IS | 0.9 ± 4.4 | 0.8 [0.4] | 7.5 | 0 |

*SBP* systolic blood pressure, *HR* heart rate, *RR* respiratory rate, *RTS* revised Trauma Score, *MGAP* mechanism, Glasgow coma scale, age, pressure, *CGS* Glasgow coma scale, *SI* shock Index

The overall in-hospital mortality rate was 18.6% ($n = 350$), including the 44 DOA patients.

A total of 718 patients (38.1%) met META criteria for UESA classification. The clinical characteristics of the UESA vs. non-UESA patients are shown in Table 4. Upon arrival of the EMS at the scene, UESA patients had a lower SBP and a higher HR than the non-UESA group. No statistically significant differences in RR were observed. Physiological trauma scores (RTS, SI, and MGAP scales) were significantly worse in the UESA group. No statistically significant between-group differences in GCS scores were observed. The prehospital time was shorter for UESA

**Table 4** Baseline characteristics and hospital clinical course

| | UESA ($n=718$) | Non-UESA ($n=1164$) | $p$ value |
|---|---|---|---|
| Age, median [IQR] | 34.0 [19] | 35.0 [27] | 0.123 |
| Gender, male (%) | 596 (83.1) | 853 (73.3) | <0.001 |
| Blunt trauma (%) | 254 (35.4) | 1164 (100) | <0.001 |
| Vital signs | | | |
| SBP (mmHg), median [IQR] | 100.0 [50] | 120.0 [30] | <0.001 |
| SBP < 90 mmHg (%) | 314 (43.7) | 0 (0) | <0.001 |
| SBP < 110 mmHg (%) | 389 (54.2) | 247 (21.2) | <0.001 |
| HR (bpm), median [IQR] | 98 [35] | 90 [25] | <0.001 |
| HR > 100 bpm (%) | 350 (48.6) | 448 (38.6) | <0.001 |
| HR > 120 bpm (%) | 169 (23.5) | 159 (13.7) | <0.001 |
| RR, median [IQR] | 18 [6] | 18 [5] | 0.491 |
| Scores | | | |
| RTS, median [IQR] | 12 [3] | 12 [1] | <0.001 |
| MGAP, median [IQR] | 23 [7] | 26 [6] | <0.001 |
| GCS, median [IQR] | 15 [6] | 15 [5] | 0.263 |
| SI, median [IQR] | 0.9 [0.7] | 0.7 [2.3] | <0.001 |
| ISS, median [IQR] | 16 [14] | 19 [20] | <0.001 |
| CPR (%) | 56 (7.8) | 10 (0.9) | <0.001 |
| Airway intubation (%) | 224 (31.2) | 337 (28.6) | 0.301 |
| Prehospital time (min), median [IQR] | 44.5 [24] | 50 [29] | <0.001 |
| Surgical and/or interventional procedures (%) | 587 (88.8) | 800 (68.7) | <0.001 |
| Mortality (%) | 183 (25.5) | 167 (14.4) | <0.001 |

*UESA* urgent evacuation for surgical assessment, *SBP* systolic blood pressure, *HR* heart rate, *RR* respiratory rate, *RTS* revised Trauma Score, *MGAP* mechanism, Glasgow coma scale, age, pressure, *CGS* Glasgow coma scale, *SI* shock Index, *ISS* Injury Severity Score, *CPR* cardiopulmonary resuscitation

patients. Compared to non-UESA patients, a higher proportion of the UESA patients (88.8% vs. 68.7%, $p<0.001$) required some type of therapeutic intervention (Fig. 3). The mortality rate was significantly higher in the UESA group (25.5% vs. 14.4%, $p<0.001$) (Fig. 3).

## Discussion

Given that most currently available MCI triage systems do not evaluate the need for surgery, the main aim of the current study was to retrospectively apply the recently developed META triage system to patients included in a severe trauma registry to: (1) determine whether the META can reliably identify patients likely to benefit from urgent surgical assessment and (2) characterize the clinical profile of these patients. Our hypothesis was that this prehospital triage method for MCIs would allow for a more precise identification of those casualties in need of urgent transfer for surgical assessment. Our findings confirm the validity of this hypothesis. The patients classified as in need of urgent surgical assessment (UESA) at the scene presented significantly worse physiological trauma scores (RTS, SI, and MGAP scales) as compared to non-UESA patients. The anatomical injuries in the UESA group were less severe, but these patients had a greater need for urgent surgery and higher mortality rates.

Studies have shown that the most important outcome variables of existing triage systems with regards to allocating and optimizing resources are: (1) anatomical severity (ISS > 15) and (2) a combination of the following: need for non-orthopedic surgery, length of ICU stay, and patient mortality. At present, there is no consensus regarding the optimal prehospital triage system [21]. Despite efforts to develop prehospital classification and intervention guidelines in MCIs, the available evidence base remains poor [22]. In this context, the META is a triage model created to identify patients who require urgent surgical assessment in MCIs and, therefore, receive priority for urgent evacuation [15].

Patients with penetrating trauma accounted for an unusually high proportion (close to 25%) of all patients in our registry compared to other international registries, both classic and more recent ones [23, 24]. Of the main international registries, only the Israeli registry had a higher proportion of penetrating trauma cases [25]. These differences can be explained by the fact that our centre is a reference centre for penetrating trauma for one of the two main EMS in the Community of Madrid, and also because penetrating

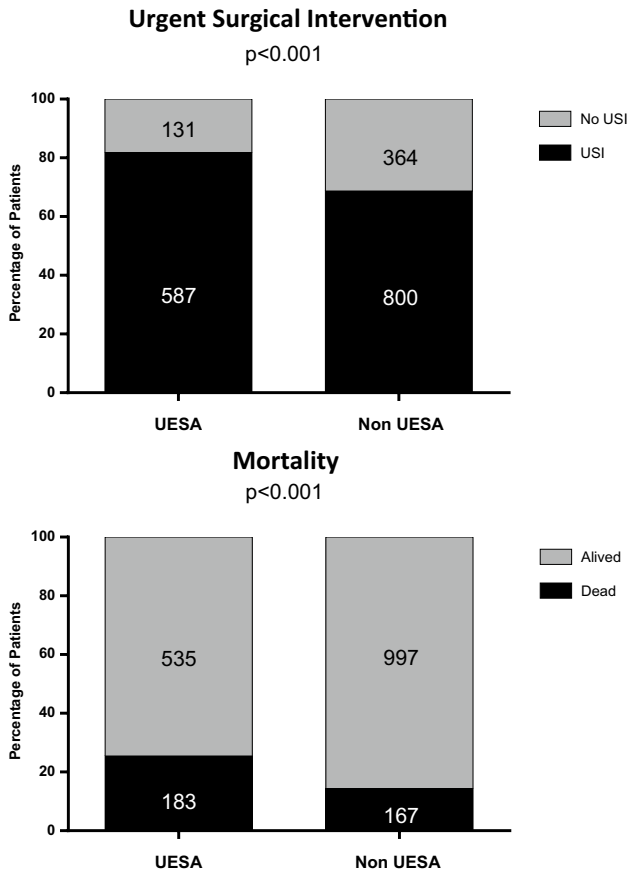


**Fig. 3** Urgent surgical intervention and mortality. *UESA* urgent evacuation for surgical assessment, *non-UESA* all other cases, *USI* urgent surgical intervention

trauma, regardless of severity, was an inclusion criteria for this registry. Regional registries in Spain (TRAUMCAT, RETRAUCI, and Navarra) [26] also report lower rates of penetrating trauma cases.

Hemodynamic stability is an important parameter to identify UESA patients, and it was included in the META system for this reason. On-scene SBP is also considered a key parameter, which is why it is included in numerous triage systems and severity scales [4, 15, 27]. SBP is also considered a reference value in studies conducted to validate severity scales [28]. Prehospital hypotension, defined as SBP < 90 mmHg [29], is associated with higher mortality rates, greater anatomical severity (ISS), and the need for urgent surgery. However, the true prognostic value of on-scene hypotension remains uncertain. The ASCOT (American College of Surgeons Committee on Trauma) guidelines recommend that patients with an SBP < 90 mmHg at the scene be immediately transferred to a trauma centre, although other studies recommend transfer based on a cut-off of SBP < 110 mmHg [30]. More recent publications recommend these same values (i.e., SBP < 110 mmHg) as a cut-off point to define hypotension for both blunt and penetrating trauma [17]. Patients in our sample designated as UESA presented lower on-scene SBP values than non-UESA patients; in addition, the proportion of hypotensive patients in the UESA group was higher, regardless of the specific cut-off value (SBP < 90 or < 110 mmHg).

In addition to SBP, heart rate is another key parameter for hemodynamic assessment in any emergency setting. Tachycardia is traditionally considered an early sign of hypovolemic shock; however, some authors disagree, arguing that because hypotension and shock are rarely correlated with tachycardia, the prognostic value of HR is likely to be minimal [31, 32]. On-scene HR was higher in patients in our sample classified as UESA vs. the non-UESA patients. The proportion of hypotensive patients was higher in the UESA group, both for HR > 100 bpm and HR > 120 bpm. The SI severity scale combines HR and SBP into a single value, thus quickly providing information about the patient's hemodynamic status. Adult trauma patients with an SI > 0.9 have worse clinical parameters and higher mortality rates [27, 33], and an increased risk of bleeding that may require a transfusion and/or surgery, or an interventional radiology procedure [34]. Compared to the non-UESA patients in our sample, patients classified as UESA presented significantly higher on-scene SI values, although the median value was just under the upper limit (≤ 0.9) established in validation studies.

In short, as several studies and trauma registries have shown, hemodynamic instability at the scene is a predictor for the need for surgery and/or radiological intervention [35, 36]. Lin et al. prospectively evaluated several triage systems to determine their relative capacity to identify severe trauma. Based on the findings of that study, the authors recommended prioritizing evacuation for urgent surgical intervention in victims who present ≥ 2 of the following characteristics: altered mental status, HR > 130 bpm, SBP ≤ 90 mmHg, and penetrating trauma [35].

Our findings with regards to the other severity scales are consistent with previous reports. The mean on-scene RTS score (10.4) was similar to that reported in other severe trauma studies [26, 37]. Although our sample was similar to that of the Dutch registry, the RTS scores in our sample were higher, possibly because the Dutch study limited the definition of severe trauma to anatomical criteria alone (i.e., ISS) [38]. The MGAP triage system is, together with the RTS, one of the most commonly used systems. The mean MGAP (22.8) in our sample was similar to the mean values reported by Sartorius—the developer of the MGAP—and to the values reported in other studies [37, 39]. Although we found no differences in GCS scores—a scale that is included as a part of both the MGAP and RTS scales—between the UESA and non-UESA patients, some studies suggest that the GCS may be useful to predict the need for surgical intervention [36]. We found no significant differences in respiratory rates between the UESA

and non-UESA patients, a finding that is consistent with the published literature, indicating that RR alone adds no predictive value to the other study variables [40], which explains why this parameter is not included in most trauma registries.

In terms of the on-scene manoeuvres performed by the EMS, CPR was performed more frequently in the UESA group; however, there were no significant differences between the UESA and non-UESA patients with regards to orotracheal intubation. The Brain Trauma Foundation guidelines recommend tracheal intubation in patients with a GCS score $\leq 8$ [41], but some authors argue that this technique only improves the prognosis in selected patients [traumatic brain injury (TBI) and GCS $\leq 8$] [42]. Although some studies have found that tracheal intubation offers little to no survival benefit compared with bag-valve-mask ventilation (especially in TBI) [43], recent studies confirm that prehospital intubation performed by physicians ensures that the airways are secured and improves oxygenation [44].

The debate over "scoop and run" vs. "stay and play" remains unresolved, largely due to a lack of evidence. However, there is some agreement that transport to the hospital should not be delayed when the incident occurs in an urban environment with a nearby trauma centre [45, 46]. This aspect is even more important in case of MCIs, where transport to hospital could be delayed due to a chaotic situation and lack of resources [1].

A recent study involving patients in the Trauma Audit Research Network (TARN) concluded that three variables—the GCS score, respiratory rate, and age—should be valued more highly as predictive triggers for transport to a major trauma centre [47]. In our study, the overall time in prehospital care—which includes arrival of the EMS team at the scene and transport to the hospital—was lower in the UESA group, a finding that demonstrates that, even though the META system was not used to evaluate these cases in real time, the UESA patients were transferred more rapidly than non-UESA patients to a trauma centre, in line with current recommendations [3]. It is important to note that in this study we evaluated only independent incidents rather than MCIs, even though the META was originally designed to assess MCIs.

Some type of therapeutic intervention was necessary in nearly 75% of our sample. The intervention rate was higher than reported in most other studies [23, 26, 35], probably because all penetrating trauma cases are classified as UESA in the META system. The percentage of patients in our sample requiring a surgical procedure was also higher than the rates reported in large registries and other studies [35]. By contrast, anatomical severity (based on ISS scores) was lower in the UESA group than in the non-UESA patients, indicating that the UESA patients who required some type of intervention were not the most anatomically severe cases, undoubtedly due to the large proportion of non-severe penetrating trauma cases included in our registry.

The overall mortality rate in our registry (18.6%) was high, although this may be partially attributed to the inclusion of DOA patients. However, due to the heterogeneity in the criteria for inclusion in trauma registries, it is difficult to compare our results to other studies and registries. For example, the mortality rate was higher in our sample than in the study conducted by Bulguer et al., who reported similar ISS values but a lower proportion of penetrating trauma cases [48]. Similarly, mortality rates in our sample cannot be compared to American or European registries because those registries do not specify ISS cut-off values [23]. In our sample, mortality rates were significantly higher in the UESA patients than in the non-UESA patients.

## Study limitations and strengths

The main limitations of this study are those inherent to its retrospective design and prolonged inclusion period (from 1993 until the year 2011). During this time period a new EMS agency, created in 2002, was added to the original one, and both brought patients to our ED. They somewhat differ in their approach to trauma care in the field, with the second one more prone to a policy of "stay & play" vs the "scoop & run" policy of the original one. The overall percentage of penetrating trauma cases has not changed during the inclusion period, although with a lesser physiologic and anatomic severity during the last 10 years.

In addition, this was a single centre study of isolated incidents rather than MCIs. Consequently, these results need to be validated using data from other trauma registries to establish the value of this triage system in other populations and settings, and using data from real MCIs. Despite these limitations, we believe these results provide valuable data to support the predictive capacity of the META triage system. The results show that this instrument may achieve its designed aims of identifying those patients who require urgent surgical assessment in case of MCIs. This tool may be useful to assess trauma patients outside of an MCI.

## Conclusion

This study provides a clear clinical profile of patients who require urgent surgical assessment according to the criteria in the META triage system for MCIs. At the scene of injury these patients typically had worse hemodynamic parameters and a greater severity on the physiologic trauma scores, but had less severe anatomical injuries. We found no differences between urgent and non-urgent cases in terms of neurological status or need for tracheal intubation. Patients classified as needing urgent surgical assessment were more likely to undergo surgery and had higher mortality rates. Overall, the findings of this study suggest that the META triage system could reliably identify severe trauma patients in need of urgent surgical assessment in case of MCIs.

## Compliance with ethical standards

**Conflict of interest** Rodolfo Romero Pareja declares that he has no conflict of interest. Rafael Castro Delgado declares that he has no conflict of interest. Fernando Turégano Fuentes declares that he has no conflict of interest. Israel Jhon Thissard-Vasallo declares that he has no conflict of interest. David Sanz Rosa declares that he has no conflict of interest. Pedro Arcos González declares that he has no conflict of interest.

**Ethical statement** The study was approved by the Research Ethics Committee of the GMUGH.

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