# Assessment of the Mass Casualty Triage during the November 2015 Paris Area Terrorist Attacks: Towards a Simple Triage Rule

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# Key Points

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**Question:** Was the prehospital triage performed during the 2015 Paris terrorist attack appropriate ?

**Findings:** Among 337 casualties admitted to the hospital, 262 (78%) were triaged, 74 (22%) as absolute emergency (AE), 188 (56%) as relative emergency (RE). The proportion of appropriately classified was 0.82 [95%CI 0.76-0.86], undertriage 0.36 [95%CI 0.27-0.47], and overtriage 0.08 [95%CI 0.04-0.13], resulting in no detectable adverse effect when considering mortality. The qualitative analysis of severe under- and overtriage indicates some room for improvement.

**Meaning:** A simple binary triage categorization can be performed on scene in a large proportion of casualties and had good diagnostic performance during a massive event with multisite and multitype attack.

## Key words

Triage; Disaster medicine; Emergency Surgery; Gunshot wound; Mass casualty; Terrorism

## Abstract (263 words)

BACKROUND : Triage is a key principle in the management of mass casualty incidents. The objective of this study was to assess the triage performed during the 2015 Paris area terrorist attack.

METHODS : This was a retrospective cohort study collecting medical data from all casualties of the attacks on November 13th 2015 in Paris and its suburb Seine Saint-Denis, France, with body injuries , who arrived alive at any hospital within the first 24 hours after the events. Prehospital triage was performed using a dichotomous scale of absolute emergencies (AE) and relative emergencies (RE), which was then compared to that performed by an expert panel (reference method).

FINDINGS: Among, 337 casualties admitted to the hospital, 262 (78%) were categorized during the prehospital phase, 74 (22%) as AE, 188 (56%) as RE. The expert categorization was AE in 119 (35%) and RE in 218 (65%) of cases. Undertriage was 0.36 [95%CI 0.27-0.47], overtriage 0.08 [95%CI 0.04-0.13], and the proportion of appropriately classified 0.82 [95%CI 0.76-0.86]. A subgroup of casualties (n=115) were triaged again at arrival to the hospital, but the diagnostic performance was not significantly modified. Among undertriaged casualties, 8 (23%) were considered as being severely undertriaged. Among overtriaged casualties, 10 (77%) were considered as being severely overtriaged. The observed mortality in the whole cohort (n=7; 2.1%) was not significantly different from that expected (n=11, 3.3%; P=0·92).

INTERPRETATION: A simple triage categorization had good diagnostic performance, resulting in no detectable adverse effect when considering mortality. Qualitative analysis of under- and overtriage indicate some possibilities for further improvement.



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## Introduction

Major incidents resulting in mass casualties occurs more frequently and challenge our ability to provide the best care to most people. Unfortunately, western countries have experienced an increasing number terrorist attacks using fire-arms, explosives, and trucks.[1-5] These attacks designed to kill and injure the largest number of casualties, using simultaneous attacks and/or multiple means, require an appropriate medical organization.[2] Triage is a key principle in the management of major incidents, comprising early identification and transport to the most appropriate center within the most appropriate delay. Although both undertriage and overtriage are of paramount importance during a major incident, there is limited evidence based on existing triage tools. Since prospective research in this area is difficult to conduct, and probably unethical, most information has been obtained during simulation research which may not apply to real conditions.[6-8] Analysis of the triage during major incidents may also be difficult because of either small sample size, study heterogeneity, and/or biased selection of studied casualties.[9,10] A systematic review concluded that field triage systems do not perform consistently during mass casualty events.[11]

In 2015, Paris and its suburb Seine Saint-Denis were the scene of multiple terrorist attacks which were unprecedented since the Second World War in Europe.[3-5] In the present study, we analyze the prehospital triage which was performed using a dichotomous scale (absolute emergencies (AE) vs relative emergencies (RE)). This simple triage tool was chosen because it corresponded to that taught and practiced in France for more than 30 years now,[12] following the principle of simplicity recommended after the London attacks in 2005.[1]

We aimed at assessing the diagnostic performance of this triage in this unique cohort of patients, on a quantitative and qualitative basis, and test its reliability. We believe this analysis is important and provides relevant information to improve our emergency plans.

## Material and methods

This observational retrospective cohort study used medical data from casualties of the Paris area terrorist attacks, collected anonymously, as recently described.[5] Data processing authorization was obtained from the Commission Nationale Informatique et Liberté and the Comité de Protection des Personnes Ile de France, exempting casualties from giving their consent for the use of their data for observational research purposes. This report follows the STROBE recommendations.[13]

*Study population*

Casualties included in the study were those with somatic lesions and who arrived alive at the hospital within the first 24h after the attacks of 13 November 2015.[5] Casualties without somatic lesions, consulting for psychological trauma, those with no recorded medical condition and who did not require hospitalization, or those presenting to hospital later after the events were excluded. Casualties were managed and transported to hospitals by mobile intensive care units and/or by Fire-Brigade ambulances according to the French standards of prehospital care.[14] Hospital orientation was managed by the Service d'Aide Médicale Urgente (SAMU) a medicalized civil emergency medical service based on the pre-hospital evaluation and categorization. When needed, priority was given to secure the premises before access to casualties and their evacuation to hospitals in the Paris region, five of them being civilian level-1 trauma centers.[5] The two military hospitals were also considered as level-1 trauma centers. Patients who were declared « dead on scene » (decision taken by an emergency physician) were not taken by the EMS but by police units and thus not transported to an hospital but directly to the legal medicine institute which is centralized for the Paris area and not situated in an hospital.

*Measurement and analysis*

Casualties were identified thought police and hospital registers.[5] Descriptive data, wounding process, anatomical lesions, pre-hospital triage, mean times of transfer to hospital and surgery

rooms, and therapeutic and diagnostic measures were collected using each casualty medical files.[5] The revised trauma score (RTS) scores, Abbreviated Injury Score (AIS), Injury Severity Score (ISS), and the Trauma Related Injury Severity Score (TRISS) were calculated.[15,16] Observed mortality was defined as the occurrence of death during hospitalization and compared to expected mortality.[16] Transfer was defined as referring the casualty to a hospital other than the one that initially received the casualty, within 24 hours of the injury process.[5]

Casualties were categorized as AE or RE (*Electronic supplement Table S1*) then referred to level-1, 2 or 3 trauma centers with appropriate level of care. The pre-hospital categorization came from administrative files of the Préfecture de Police de Paris and from the Assistance Public-Hôpitaux de Paris respectively named "SINUS" and "VICTIMS.[5] In a subgroup of casualties admitted into the level 1 trauma centers, a secondary triage was performed at admission to the hospital (AE/RE) by experienced senior physicians. The final categorization (reference method) was established independently by two senior experts (AJ, MR) from an examination of the complete medical chart (Kappa score 0.92).[5] In case of disagreement a consensus was reached by a third expert (BR).

To qualitatively assess the performance of triage, we analyzed undertriage (those classified RE in the prehospital phase but AE by the experts) and overtriage (those classified AE in the prehospital phase but RE by the experts) of the prehospital triage process. Among undertriaged casualties, we selected those with at least one anatomic lesion with AIS scoring > 3 (*i.e.*, severe undertriage). Conversely, among overtriaged casualties, we selected those with only anatomical lesions AIS scoring 1 or 2 (*i.e.*, severe overtriage). In both undertriaged and overtriaged casualties, those with AIS scoring = 3 were considered as equivocal (*i.e.*, non severe under/overtriage).

Lastly, we compared prehospital triage performed in real condition to simulated triage using the three most widely used triage tools: the Field Triage Score (FTS),[17] the Simple Triage and

Rapid Treatment (START) algorithm,[18] and the more recent Modified Physiological Triage Tool (MPTT).[19] Since these triage tools were based on a 3 levels classification, we transformed them into dichotomous tools as follows: FTS 0 or 1, START "immediate" and MPTT "P1" were considered as AE, whereas FTS 2, START "minor" and "delayed", and MPTT "P2" and "P3" were considered as RE. These simulated triages were established independently by two senior experts (JPT, AJ) who accessed only to variables available in prehospital conditions. This analysis took place one year after the reference categorization without knowledge of it.[5] In case of disagreement a consensus was reached by a third expert (MR). Kappa scores for TS, START, and MPTT were 0.95, 0.92, and 0.50 respectively. To compare these scores to prehospital triage, the main criteria was the proportion of patients appropriately classified.

*Statistical analysis*

Qualitative variables are presented by number and percentage. Quantitative variables are presented by their mean±standard deviation or median [interquartile] according to the normality of the distribution. Comparison between groups was performed using the Fisher exact method, the Student t test, and the Mann Whitney test. To assess the diagnostic performance, we calculated the undertriage (1-sensitivity), overtriage (1-specificity), negative and positive predictive values, negative and positive likelihood ratio, and proportion of patients appropriately classified (*Electronic supplement S2*). Comparison of undertriage, overtriage and proportion of appropriately classified was performed using the Mc Nemar test. Comparisons of predictive values and likelihood ratios were performed.[20,21] The Bonferroni correction was applied for multiple comparisons. Missing data were not replaced. We used Kappa statistic to measure inter-rater reliability when several experts was involved to categorize a single parameter. A Kappa close to 0 indicates no agreement when a Kappa close to 1 indicates a perfect agreement.

All comparisons were two-tailed and a P value <0·05 was considered significant. Statistical analyses were carried out using R (version 3.6.1) software.

## Results

Among 543 casualties with body injuries, 337 were admitted to emergency services/trauma centers (Figure 1). Two hundred and sixty two (68%) of these casualties were categorized during the prehospital phase, 74 (28%) as AE, 188 (72%) as RE. One hundred and fifteen (34%) casualties were again categorized at admission into level 1 trauma centers, 52 (46%) as AE, 63 (64%) as RE. The expert hospital categorization was AE in 119 (35%) and RE in 218 (65%) of cases (Table 1, Figure 2). In casualties not triaged during the prehospital phase (n=75), there were 23 (31%) AE and 52 (69%) RE. Secondary transfer occurred in 27 (8%) casualties (12 AE and 15 RE), 4 of them being referred to a level-1 trauma center (1 AE and 3 RE).

The diagnostic performance of prehospital triage is shown in Table 2. The comparison of prehospital and hospital triages is shown in table 3. Among undertriaged casualties (n=35), 8 (23%) were considered as severely undertriaged. Among overtriaged casualties (n=13), 10 (77%) were considered as severely overtriaged. The main causes of severe undertriage were related to thoraco-abdominal and head penetrating injuries and most severe cause of overtriage were related to superficial limb lesions (*Electronic supplement Table S3*).

Using simulated triage with access only to prehospital variables, the diagnostic performance of FTS, START, and MPTT were significantly lower than that observed in our cohort when considering the proportion of casualties appropriately classified. Although the overtriage of FTS, START, and MPTT was worse than that observed in our cohort, undertriage in this group was better (*Electronic supplement Table S4)*.

The observed in-hospital mortality (n=7; 2·1%) was not significantly different from that expected (n=11; 3.3%; P=0·92).

# Discussion

*Synthesis*

Our study shows that a simple triage categorization (AE/RE) was performed on scene in a large proportion of casualties (78%) and had good diagnostic performance during highly complex incident involving multiple incident sites, and both gunshot and explosion. This diagnostic performance did not result in detectable adverse effects since the observed mortality during this mass casualty incident was not higher than that expected during routine trauma care. Nevertheless, the qualitative analysis of severe under- and overtriage indicates that there is some room for improvement. In a subgroup of casualties, we observed that secondary triage at hospital admission did not significantly improve the proportion of patients appropriately classified. Lastly, simulated triage using other triage tools (FTS, START, MPTT) did not perform better than the simple prehospital triage used.

*Perspectives*

Wartime triage was initially meant to establish surgical priority at a time when this process was the only decisive factor in the prognosis of war casualties.[6] The evolution of war medicine has given rise to the need to prioritize access to other scarce resources such as blood products, diagnostic methods and life-saving interventions prior to surgery. As a result, preoperative and pre-hospital categorization tools have been added to classic surgical triage without replacing it. Most of them were based on physiological data (consciousness, arterial blood pressure, heart and respiratory rates) since they predict both mortality and resource utilization.[22,23] Based on the analysis of radial pulse and consciousness, FTS is the most simple illustration of this rationale.[17] NATO preferred using the START algorithm based on four variables: walking ability, breathing, radial pulse, and ability to execute a simple order.[18] This algorithm has been adopted with minimal adjustments by the British and Australian rescue services and the most recent result of its use in Middle Eastern conflicts is the MPTT.[19] The later was derived from a

large cohort of 6,095 war casualties managed consecutively at Camp Bastion in Afghanistan, and prospectively validated on a cohort of 354 war casualties in the same center, demonstrating a lower undertriage rate (16%) than comparable triage tools.[19] However, these war triage tools were built and tested for hospital triage by physician and not prehospital triage. As no triage policy has ever given complete satisfaction to its end-users, it is very likely that they will continue to evolve, mainly to distinguish very quickly the most urgent category of casualties, *i.e.* avoiding undertriage. This tends to create a simple pre-hospital categorization into only two groups.

The dichotomous scale (AE/RE) corresponds to that taught in France after previous terrorist attacks,[12] in line with the more recent recommendations of simplicity.[1] This simple tool is widely used in France by paramedics and firemen, as well as media and justice officers.[24,25] The reference standard (expert panel) was appropriate when considering that no admission to ICU, blood transfusion, embolization, or death was noted in casualties sorted as RE, and no discharge on day 1 was noted in casualties sorted as AE. Our study shows that using this simple categorization, 78% of the casualties of a multisite terrorist attack were effectively sorted in the prehospital settings, indicating that it was effectively applied despite the very high number of casualties and persistence of the threat.[5] This method seems more adapted to these circumstances than those conventionally used for prehospital triage like the FTS, START or MPTT. In the setting of a terrorist attack, these tools proved to be too complicated to use because they require applying an algorithm, measuring vital parameters and filling in a triage tag. Such a complex process is probably unrealistic in the confusion created by a large-scale terrorist attack, in a dangerous environment where emergency teams are under extreme pressure to stop bleeding and evacuate quickly the victims while facing the threat of continuing terrorist attacks. Consequently, during massive shootings, pre-hospital triage can be under-used or not used at all with the risk of important overtriage since the rescue teams will tend, for safety, to

transport all the casualties with penetrating trauma only to a level 1 trauma center to the detriment of level 2 or 3 centers which could be less overcrowded and adapted to the care of RE if they had been appropriately categorized. The AE/ER binary triage limiting overtriage seems then adapted to mass casualties with penetrating injuries during terrorist attacks. The proportion of undertriage and overtriage observed during the Paris attacks (36 and 8%, respectively) should be compared to the best one reported by trained surgeons during war conditions (16 and 28%, respectively).[23] In the Paris massive event, overtriage was limited, preventing hospital saturation, but undertriage was higher than those observed with other scores. Only 12 AE casualties needed secondary transport, only one of them to a level 1 trauma center. Moreover, the AE/RE method did not adversely interfere with the care of patients since the mortality observed during a massive event was comparable to routine care in traumatology. It should be pointed that this triage process does not apply to the "hot zone" where tactical medical units intervene.[26]

The qualitative analysis provided some clues for future improvement. Emphasizing the need for staging thoraco-abdominal lesions as AE and conversely staging limb lesions without severe hemorrhage as RE may easily and further improve the diagnostic performance of prehospital triage (*Electronic supplement Table S4).* The comparison of the triage diagnostic performance on scene and on arrival at the hospital in a subgroup of casualties showed no significant difference in the proportion of casualties appropriately classified, suggesting that it is reproducible (Table 3).

In France, the AE/ER triage concept has been widely used, not only by professional health care providers but also by the media and live TV channels publishing reports of multiple casualty incidents or terrorist attacks.[24,25] Consequently, it was understood by the public and adopted as common reporting language tool for all (medical and non medical) services involved. In the future, in accordance to the Hartford consensus,[27] outlining the crucial role of the public to

"stop the bleeding", the bystander's use of this simple triage concept could also be considered to improve prehospital care organization. A binary categorization is simple to understand, easy to remember and to implement even during stressful events, it does not require complicated measures because it relies on a global and visual assessment of the wounded, it can be taught quickly and performed by first responders, EMTs and also by more specialized teams including physicians enabling everybody to speak the same language. This simple binary approach is flexible and can be used to assess priority for extraction, emergency care and transport of casualties.

*Strengths and limitations*

The strengths of our study are related to the large number of casualties and use of diagnostic research methodology.[28] Several limitations should be noted. Because this study was retrospective, it suffers from possible bias, particularly the existence of missing data related to the non-standardization of information from medical records. The injuries were less severe than those previously reported in mass casualty events,[29,30] since all casualties were included.[5] We did not include casualties deceased on scene and thus reported in-hospital mortality among patients that arrived alive at hospital which is significantly lower than the overall mortality of the event (24%). Lastly, data concerning FTS, START, and MPTT were obtained using simulation and not in real conditions and the fact that we used a dichotomous categorization as the reference one may have also biased the comparison.

# Conclusion

Analysis of the 2015 Paris area terrorist attacks showed that a simple triage categorization had relatively good diagnostic performance, resulting in no detectable adverse effect when considering mortality. Nevertheless, the qualitative analysis of severe under- and overtriage

indicate some room for further improvement. These elements will make it possible to better adapt management plans for massive events.

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**Author contributions:**

AJ, MR and BR conceived and designed the study. AJ, JPT, MR and BR analysed and interpreted the data. AJ, MR, and BR wrote the initial draft. AJ and BR performed the statistical analysis. All authors subsequently critically edited the report, read and approved the final report. MR had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis. MR and BR obtained funding and supervised the study.

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# Figure legends

## Figure 1

Study flow chart. AE: absolute emergency; RE: relative emergencies.

## Figure 2

Global cumulative frequency distribution of delay (min) from time of injury to hospital admission (A) and from time of hospital admission to first surgery (B) *in* absolute (AE; n=119) and relative emergencies (RE; n=218), according to the expert panel classification. P values refer to the comparison of medians.