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# The speed and accuracy of prehospital triage for simulated disaster patients: Comparing prehospital emergency triage rapid algorithm (PETRA) and simple triage and rapid treatment (START)

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**ABSTRACT**

**Objectives:** The prehospital emergency triage rapid algorithm (PETRA) method was designed to overcome the deficiencies of the earlier described simple triage and rapid treatment (START) method. This study has compared the START and PETRA triage methods regarding the appropriateness of triaging victims following a simulated mass casualty incident in terms of accuracy and time efficiency. The two triage systems were compared.

**Methods:** This was a prospective study using a convenience sample of randomly distributed paramedic students between September 2022 and December 2022 at the Civil Defense College in Amman. Sample 102 students of the paramedic diploma program at the College. Total time of prehospital triage, accuracy of prehospital triage, level of under triage, and level of over triage were measured for both study groups.

**Results:** Independent t-test revealed that there was no significant difference between the PETRA and START methods in terms of the prehospital triage accuracy, time spent in prehospital triage, and level of over triage. However, the level of under triage in the PETRA group was lower compared to the START group.

**Conclusion:** The study proposes that the paramedic should adopt the PETRA method as an improved alternative to the START method during a massive causality incident. In the same way, this research encourages the incorporation of the PETRA method in the curricula of paramedics and nurses. More research is required to support the existing findings.

**Keywords:** disaster, PETRA, START, prehospital triage, triage methods

## INTRODUCTION

Ecological, social, economic, political, and health implications often transgress national borders, making disasters and mass casualty incidents (MCIs) increasingly frequent and damaging, jeopardizing health and life in general and placing healthcare systems under pressure [1]. Disasters and MCIs are situations or events in which the emergency medical system is overwhelmed because of the large number of victims and the seriousness of their cases presenting simultaneously [2]. In such situations, the urgent needs of victims outweigh the available services, increasing mortality and morbidity rates [1]. Thus, the concept of triage, which results in immediate sorting out disaster victims, is important to detect those who have the largest need for immediate medical services, and to allocate health system resources for optimum effectiveness [2].

Triage refers to classifying victims to prioritize care according to their needs [1]. The basic principle of triage includes determining the severity of injury and the likelihood of survival for each victim, putting the victim into a category of triage, and then provide adequate treatment based on category [2]. Awareness of proper triage methods is a valuable skill for both first responders and first receivers who provide treatment to victims [2, 3]. The simple triage and rapid treatment (START) method of triage is currently used worldwide by emergency medical services and paramedic personnel to sort affected people in an MCI in reference to the severity of their injuries. After dividing MCI victims into ambulatory and non-ambulatory, they are classified according to physiological parameters (e.g., walking ability, respiration rate, capillaries filling, radial pulse and command compliance) into one of four color classifications: black for deceased, red for immediate, yellow for delayed, green for walking injured, or minor injured victims [4-6]. Color triage tags help all involved

parties to quickly identify the status of victims, and to deliver required care with optimum efficacy [5].

Any victim who can walk when paramedics arrive to the scene will be classified as ambulatory and will be given green tag; others will be classified as non-ambulatory and will be given other colored tags according to their particular characteristics and needs [7]. Victims who cannot breathe will get the only possible medical intervention, usually done by the paramedic personnel, who try to open their airways [8]. If these victims do not respond and do not breathe further, they are classified deceased, with a black triage tag [8]. Victims who have respiratory rates higher than 30 per minute, absent radial pulse, capillary refill over 2 seconds, or who are unable to follow simple commands are classified as immediate victims, with a red color triage tag [7-9]. Victims out of the previous three classifications are classified delayed victims with yellow tag. Some modifications are done on the START triage method when the casualties are pediatrics, for whom the physiological criteria for color tagging are modified [8].

While it has rudimentary effectiveness for first responders and emergency care during MCIs, the START method of triage suffers from limitations, and it is prone to under triage when classifying victims, inadequate levels of sensitivity and specificity for injured patients and those requiring rapid assistance, taking a long time to perform screening and landscape assessments, and differences in the priority ranking order of victims [2].

Thus, other methods of triage have been developed to address these limitations. One method of triage that have been recently developed in Jordan is the prehospital emergency triage rapid algorithm (PETRA) [4]. This method was developed in 2019 by a collaboration between The Federal German Office of Civil Protection and Disaster Assistance (BBK), Jordan Civil Defense, and the Jordan Ministry of Health. This method is still under assessment by the Protocol Committee of the Ministry of Health. This triage method is proposed to be easily remembered by rescuers and avoids the weakness points of the START method. The color triage coding of the PETRA triage method is shown in **Figure 1** [9].

According to the PETRA method, MCI victims are categorized according to physiological criteria in one of four classifications, including black for dead, red for immediate, yellow for delayed, and green for walking wounded or minor injured victims (as with SMART, these classifications are assigned after initially separating the victims into ambulatory and non-ambulatory status) [7, 8]. When paramedics arrive at the scene, any victim found to be able to walk and who “looks well” is identified as ambulatory and is given a green tag. “Looks well” in this context refers to the victims not suffering from burns of more than 30% of the body surface area, inhalation burns, signs of shock, or major bleeding. Others are labeled as non-ambulatory, and appropriate color tags are issued, as described below [9].

Deceased victims are given a black tag; these include patients whose injuries are incompatible with life, have uncontrollable bleeding, and who do not breathe spontaneously after undergoing the only possible medical aid that paramedic workers can conduct as an attempt to open their airways by repositioning the victim’s head. Victims with a respiratory rate greater than 30 or less than 10 breaths per minute, pulse rate greater than 120 or less than 50 bpm, who are not alert or who do not respond to verbal stimuli are identified as immediate victims, with a red color tag. All other victims are classified as delayed and are given a yellow tag [9].

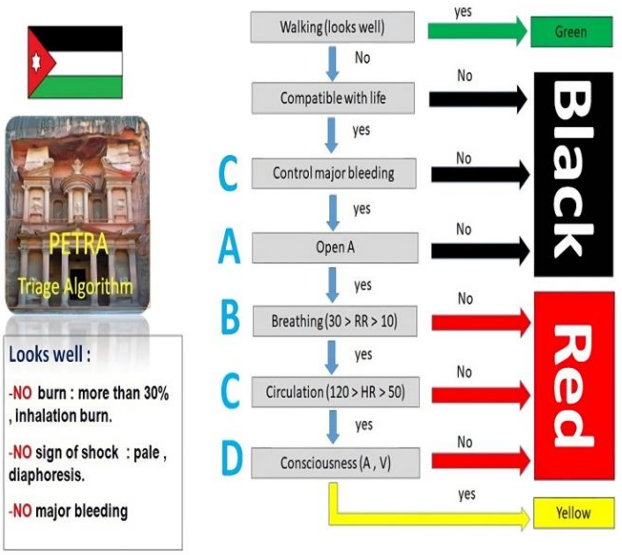


**Figure 1.** The PETRA triage algorithm [15]

According to the opinion of the Committee that developed the PETRA algorithm, the weaknesses in the START algorithm that it addresses are, as follows [4, 9]:

- The PETRA algorithm acknowledges that some people who can walk may nevertheless suffer from major injuries; conversely, using START, the assignation of a green tag implies minor injuries, thus ambulatory patients are prone to under triage.
- According to the START algorithm, severe bleeding is controlled after examining the airway, breathing, and pulse, although recent trauma patient assessment protocols agree that severe bleeding controls should be done as the first step after obvious severe bleeding is determined when obtaining the general impression of the victim; the PETRA algorithm accommodates these recent bleeding guidelines.
- In the START algorithm, when the respiratory rate is found to be less than 30 breaths per minute, the victim’s condition is considered good and no tag is given, while according to the PETRA algorithm, if the respiratory rate is less than 10 breaths per minute, the condition is considered serious, and the patient is given a red tag (because this may be a late sign of shock).
- In the START algorithm, when the pulse is detectable, it is considered that the victim’s condition is good and no tag is given, while according to the PETRA algorithm, if the pulse rate is less than 50 bpm, the condition is considered serious, and the patient is given a red tag, because it may be a late sign of shock.
- The capillary refill test that is used in the START algorithm is one possible indicator of circulatory and perfusion status, and it is more reliable for children younger than 12 years. Factors such as the patient’s age, sex, general health, and environment may affect the filling time among adults, so this measurement should be used only as a guide.

Although the PETRA method aims to address the shortcomings in the START, the most commonly used triage method throughout the world, the accuracy of the newly

developed PETRA method in practice remains to be verified. Thus, it is important to compare the performance of paramedic students using the PETRA and START triage methods in terms of the total time and accuracy of prehospital triage, considering the incidence of under triage and overtriage [4, 9].

## METHODS

### Design and Setting

A prospective study was used with a convenience sample of paramedic students who were randomly distributed to either the START or the PETRA groups during September to December 2022 in Amman's Civil Defense College. It is the only college in Jordan which provides a paramedic diploma program which prepares students to work in the Jordan Civil Defense as advanced paramedics upon graduation. It is a military educational institution that complies with the standards and regulations of the Jordan, in addition to being accredited by the Higher Education Accreditation Commission. Furthermore, the College is affiliated academically to Jordan, and administratively to the Jordan Civil Defense's Public Security Directorate. The paramedic diploma major was launched in 2006 in line with the Civil Defense Directorate's policy, which aims at the enhancement and the development of the paramedic profession in Jordan [10].

### Sample

The study sample comprised 102 students of the paramedic diploma program at the Civil Defense College. Inclusion criteria were students in the paramedic program who had completed the first year of study, whereby they were equipped with the basic knowledge and skills necessary to examine casualties, take vital signs, and perform the necessary procedures to open the airway and control bleeding. Exclusion criteria were students who had previous training or courses in the START or PETRA triage. Given an independent t-test by using G*power software 3.1., a power of 0.8, a significant level of 0.05, and a moderate effective size (0.5), the required sample size was 102 participants, distributed equally into the PETRA group (n = 51) and START group (n = 51).

### Outcome Measures

The study analyzed the following outcomes, related to *a priori* triage classifications pre-determined by the investigators [11, 12].

#### *Total time of prehospital triage*

A stopwatch was used to measure the time (in minutes) required to triage all MCI causalities in the scenario. In other words, the time from the start of the scenario until the end of the scenario or the last victim has been triaged was recorded.

#### *The accuracy of prehospital triage*

The students' causality classifications were compared to the *a priori* classifications. The total number of the MCI causalities in the scenario who were correctly classified were recorded.

#### *The level of under triage*

The number of the MCI causalities in the scenario who were classified in triage categories with lower acuity than the *a priori* classifications were recorded.

#### *The level of over triage*

The number of the MCI causalities in the scenario who were classified in triage categories with higher acuity than the *a priori* classifications were recorded.

### Study Protocol

The principal investigator determine the meeting room, during which interested students were informed of the objectives, risks, benefits, and confidentiality of the study, and they were invited to ask any questions they had about the study. If they agreed to participate and the eligibility criteria are met, informed consent would be obtained at the meeting. Finally, after this meeting, students were randomly assigned to the two study groups (the PETRA and START groups) by another researcher who did not participate in data collection, through a web-based randomization service, and then times for the study sessions set up. The students were not informed about their assigned group until the training day.

On the training day, before the simulated disaster drill, the students in each group separately attended a two-hour lecture about the triage method that they were assigned. The aim of this lecture was to inform them about the principles of disaster triage and details of the triage algorithm. Then, each group was assigned to simulated disaster drill with patients. The simulated disaster scenarios included a massive bus accident that included multiple diversely injured victims. During the disaster drill, each student was responsible for the triage of 14 casualties based on the triage algorithm which was assigned without the assistance of reference materials. Sorting out the casualties during the triage and dealing with the scene was left to the participants to do each in their own way. The rater, a faculty member in the paramedic care specialty with advanced training in both the START and PETRA triages, measured the total time needed to triage all casualties, the time needed to triage each causality, and the accuracy of their triage. Each student was given the results of the evaluation upon completion of the triage exercise, and they allowed to ask for any consideration.

### Data Analysis

Independent t-tests were used to test using SPSS for the difference in the total triage time, correct triage, under triage, and over triage between the paramedic students who used START or PETRA.

## RESULTS

### Socio-Demographic Characteristics of Study Participants

The study included 102 students from the Paramedic Diploma Program at the Jordan Civil Defense College. All participants were male, single, aged 19 years old, and in the second year's first semester of the Paramedic Diploma program. Data collection was undertaken while checking eligibility criteria.

### The Mean Differences Between PETRA and START Groups

Mean differences between the PETRA (n = 51) and START (n = 51) groups were determined using independent t-test, and variance was analyzed using Levene's test. The study sought to determine if there were any statistically significant differences between the groups in terms of the total prehospital triage

**Table 1.** Mean differences between PETRA and START groups

| Variable | M (SD) | | t (100) | p |
|---|---|---|---|---|
| | PETRA (n = 51) | START (n = 51) | | |
| Total triage time (minutes) | 6.83 (1.05) | 7.11 (1.36) | -1.13 | 0.258 |
| Correct triage | 10.72 (2.73) | 9.94 (3.07) | 1.36 | 0.177 |
| Under triage | 1.88 (1.70) | 2.78 (2.02) | -2.43 | 0.017 |
| Over triage | 1.60 (0.22) | 1.31 (0.20) | 0.57 | 0.566 |

time, accuracy, over triage, and under triage. The results are summarized in **Table 1** and are described below.

### *Total Time of Prehospital Triage*

Levene's test indicated the non-statistically significant nature of the variance of the total triage time scores around the mean (F = 1.95 and p = 0.166), indicating homogeneity between the two groups. Independent t-test showed mean-difference not significant (t [100] = -1.13, mean difference = -0.27, and p = 0.258) in total triage time mean scores between students using PETRA (mean [M] = 6.83 minutes and standard deviation [SD] = 1.05) and those using START (M = 7.11 minutes and SD = 1.36).

### *The Accuracy of Prehospital Triage*

Levene's test indicated the non-statistically significant nature of the variance of prehospital triage accuracy scores around the mean (F = 1.44 and p = 0.232), indicating homogeneity between the two groups. Independent t-test showed mean-difference not significant (t [100] = 1.36, mean difference = 0.78, and p = 0.177) in prehospital triage accuracy mean scores between students using PETRA (M = 10.72 and SD = 2.73) and those using START (M = 9.94 and SD = 3.07).

### *The Level of Over triage*

Levene's test indicated the non-statistically significant nature of the variance of over triage scores around the mean (F = 0.42 and p = 0.517), indicating homogeneity between the two groups. Independent t-test showed mean-difference not significant (t [100] = 0.57, mean difference = 0.17, and p = 0.566) in over triage mean scores between students using PETRA (M = 1.60 and SD = 0.22) and those using START (M = 1.31 and SD = 0.20).

### *The Level of Under triage*

Levene's test indicated the non-statistically significant nature of the variance of under triage scores around the mean (F = 2.77 and p = 0.099), indicating homogeneity between the two groups. Independent t-test showed mean-difference was significant (t [100] = -2.43, mean difference = 0.90, and p = 0.017) in under triage mean scores between students using PETRA (M = 1.88 and SD = 1.70) and those using START (M = 2.78 and SD = 2.02).

## DISCUSSION

This study aimed to compare the performance of the START with that of the PETRA for the triage of victims following a massive car accident. The two triage methods were compared in terms of accuracy and total time of the prehospital triage. The results showed that the PETRA method and the START method were not significantly different in terms of the accuracy of prehospital triage, the total prehospital triage time, and over triage. However, the PETRA method was found to be better than the START method in terms of under triage.

This first study comparing paramedic students' performance using START or PETRA for the triage of victims following a massive car accident. However, some studies compared the START with other triage methods. A study compared paramedic students' use of the START and the Sacco triage method (STM) during a virtual reality simulation of an actual historical train crash in terms of the total time to triage all causalities of this MCI scenario. No statistically significant difference in the total time to triage all causalities between the STM and START methods was found [11]. Also, another study found that there were no significant differences in the performance of emergency department triage nurses on the Canadian triage and acuity scale (CTAS) and the START in terms of the time of triage and the level of triage accuracy, and the over triage rate. However, they found that CTAS had a lower rate of under triage than START [13].

Our study findings corroborate those of these previous studies, revealing no statistically significant difference in terms of total prehospital triage time, the accuracy of prehospital triage, and the level of over triage for the group who used PETRA compared to the group who used START after a simulated MCI, but our study differed in finding that the level of under triage in the PETRA method group was significantly lower than that in the START group.

As discussed previously, the PETRA method was specifically designed to address limitations in START. The latter's use of a limited set of criteria to assess patients' injuries and assign them to one of four categories based on the severity to facilitate emergency responders to quickly and efficiently triage large numbers of patients in a short amount of time. However, it suffers from relatively low accuracy in identifying patients who require immediate medical attention, commonly leading to under triage of victims [13, 14]. These reported drawbacks of the START method were confirmed by the current study's results, revealing that students using the START method exhibited a significantly higher level of under triage than the PETRA method.

### Limitations

This study had limitations that potentially compromise its generalizability. For instance, only adults were included in the study scenario, limiting the applicability of the study results for pediatric populations exposed to MCIs, who have distinctive needs. It is recommended to validate the PETRA method in a pediatric population in future research. The study also recruited paramedic students from one setting who had the same gender because all paramedic students in the study setting and most paramedics in Jordan were generally male. The use of this sample limited the generalizability of the results to other paramedic students. Additionally, the convenience sampling technique used is prone to external validity issues. Furthermore, the study was conducted in a simulated, manipulated situation where the performance of paramedic students may be different in real MCIs. Thus, the evaluation of the triage methods in real practice is needed to test the effectiveness of the triage methods in a more realistic way.

### Implications

For healthcare providers, the findings of this study support the adoption of the PETRA triage method among prehospital healthcare personnel as an alternative to the START method

during MCIs, as it effectively addresses the under triage drawback inherent in the START method. In education, this study also encourages incorporating the PETRA triage method in paramedic and nursing curricula. However, In future research, it is recommended to randomly select students from multiple settings.

## CONCLUSION

This is the first study that aimed to compare the performance of the START with that of the PETRA for the triage of victims following a massive car accident in terms of the accuracy of prehospital triage, the total prehospital triage time, over triage, and under triage. The results showed that the outcomes of using the PETRA method did not differ significantly from using the START method in terms of the accuracy of prehospital triage, total prehospital triage time, and over triage; however, the PETRA method showed a significantly lower frequency of under triage than the START method. This study therefore supports the use of the PETRA method by prehospital medical personnel as an alternative to the START method during MCIs. However, further research is required before adopting this empirical conclusion in evidence-based practice.

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**Declaration of interest:** No conflict of interest is declared by the authors.

**Data sharing statement:** Data supporting the findings and conclusions are available upon request from the corresponding author.

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