# A Comparison Between Differently Skilled Prehospital Emergency Care Providers in Major-Incident Triage in South Africa

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**Abbreviations:**
ALS: Advanced Life Support
BLS: Basic Life Support
EMS: Emergency Medical Services
ILS: Intermediate Life Support
MIMMS: Major Incident Medical Management and Support
START: Simple Triage and Rapid Transport

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## Abstract

**Introduction:** Major-incident triage ensures effective emergency care and utilization of resources. Prehospital emergency care providers are often the first medical professionals to arrive at any major incident and should be competent in primary triage. However, various factors (including level of training) influence their triage performance.

**Hypothesis/Problem:** The aim of this study was to determine the difference in major-incident triage performance between different training levels of prehospital emergency care providers in South Africa utilizing the Triage Sieve algorithm.

**Methods:** This was a cross-sectional study involving differently trained prehospital providers: Advanced Life Support (ALS); Intermediate Life Support (ILS); and Basic Life Support (BLS). Participants wrote a validated 20-question pre-test before completing major-incident training. Two post-tests were also completed: a 20-question written test and a three-question face-to-face evaluation. Outcomes measured were triage accuracy and duration of triage. The effect of level of training, gender, age, previous major-incident training, and duration of service were determined.

**Results:** A total of 129 prehospital providers participated. The mean age was 33.4 years and 65 (50.4%) were male. Most (n = 87; 67.4%) were BLS providers. The overall correct triage score pre-training was 53.9% (95% CI, 51.98 to 55.83), over-triage 31.4% (95% CI, 29.66 to 33.2), and under-triage 13.8% (95% CI, 12.55 to 12.22). Post-training, the overall correct triage score increased to 63.6% (95% CI, 61.72 to 65.44), over-triage decreased to 17.9% (95% CI, 16.47 to 19.43), and under-triage increased to 17.8% (95% CI, 16.40 to 19.36). The ALS providers had both the highest likelihood of a correct triage score post-training (odds ratio 1.21; 95% CI, 0.96-1.53) and the shortest duration of triage (median three seconds, interquartile range two to seven seconds; P = .034). Participants with prior major-incident training performed better (P = .001).

**Conclusion:** Accuracy of major-incident triage across all levels of prehospital providers in South Africa is less than optimal with non-significant differences post-major-incident training. Prior major-incident training played a significant role in triage accuracy indicating that training should be an ongoing process. Although ALS providers were the quickest to complete triage, this difference was not clinically significant. The BLS and ILS providers with major-incident training can thus be utilized for primary major-incident triage allowing ALS providers to focus on more clinical roles.

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## Introduction

Major incidents typically have a chaotic aftermath and demand special arrangements to ensure the effective delivery of adequate medical management.[1] Triage is particularly important in these situations where the surge in health care demand often outweighs existing resources. Triage is therefore a critical component of major-incident medical management, ensuring that the right patient gets to the right facility at the right time.[1–3]

Major-incident triage systems differ from routine prehospital triage and are determined by the type and severity of live casualties, as well as their number and dispersion within the incident area.[4] Effective triage occurs in two phases, each phase with a different objective. Primary triage occurs at the scene of the incident before immobile patients are moved and is a rapid evaluation to prioritize casualties who need urgent medical care. Examples of primary triage algorithms are Simple Treatment and Rapid Transport (START), Sacco Triage Method (STM), Care Flight Triage, and the Triage Sieve.[2,5] Secondary triage is done at casualty receiving sites, at or close to the incident, where more time and resources are available for a more in-depth assessment.[5] Algorithms for secondary triage include Secondary Assessment of Victim Endpoint (SAVE) and Triage Sort.[6,7]

Triage algorithms allow an objective assessment according to pre-set criteria, thereby improving triage accuracy and reliability.[8] However, triage errors do occur resulting in patients being inappropriately classified. These errors subsequently lead to inappropriate resource utilization and essentially hinder the delivery of effective emergency care.[9,10] Under-triage occurs when victims with life-threatening injuries requiring immediate treatment are incorrectly classified to receive delayed care. On the other hand, over-triaged patients have non-critical injuries but are classified as urgent and thus requiring immediate care. Over-triage seems to occur more frequently than under-triage with rates documented between 40.0% and 89.0% compared to less than 15.0% of the time.[11–13]

An important reason for triage errors is the lack of adherence to the triage algorithm, occurring up to 26.0% of the time.[11,14,15] Fitzharris, et al found variations in triage performance across different training levels of prehospital personnel where the highest adherence rates (77.0%) occurred among the lowest-level trained personnel.[14] Selecting the most appropriate responder to perform triage during a major incident might help to reduce these errors.[16] The aim of this study was to evaluate and compare the triage accuracy between three levels of prehospital emergency care providers in South Africa using the Triage Sieve algorithm.

## Methods

### *Study Design*

A cross-sectional study was done from March through October 2016 after receiving approval by the Health Research Ethics Committee of Stellenbosch University (Stellenbosch, South Africa; S15/10/238).

### *Study Setting*

South Africa has a high burden of major incidents,[17] and the management thereof is guided by the 2002 Disaster Management Act.[18] It involves coordinated efforts between the Fire and Rescue Service, the South African Police Service, and Emergency Medical Services (EMS). South Africa adopted the Major Incident Medical Management and Support (MIMMS) principles as part of the Fédération Internationale de Football Association (FIFA; Zurich, Switzerland) 2010 Soccer World Cup legacy. The triage system used is that of Triage Sieve (primary triage) and Triage Sort (secondary triage).[19] Triage Sieve measures various physiological parameters that determine the priority for treatment (Figure 1). Patients are categorized into one of four groups: (1) Red (Priority 1) – Patients whose life is in immediate danger and require immediate treatment; (2) Yellow (Priority 2) – Patients not in immediate danger, but do require urgent surgical or medical intervention within two to four hours; (3) Green (Priority 3) – Patients with minor injuries; and (4) Blue (no priority) – Patients who are either dead or have extensive injuries that cannot be saved with the limited resources available.[20] Similar to the United Kingdom, use of the Blue category is controversial in South Africa with an undocumented consensus to exclude it from primary triage categories.[1]

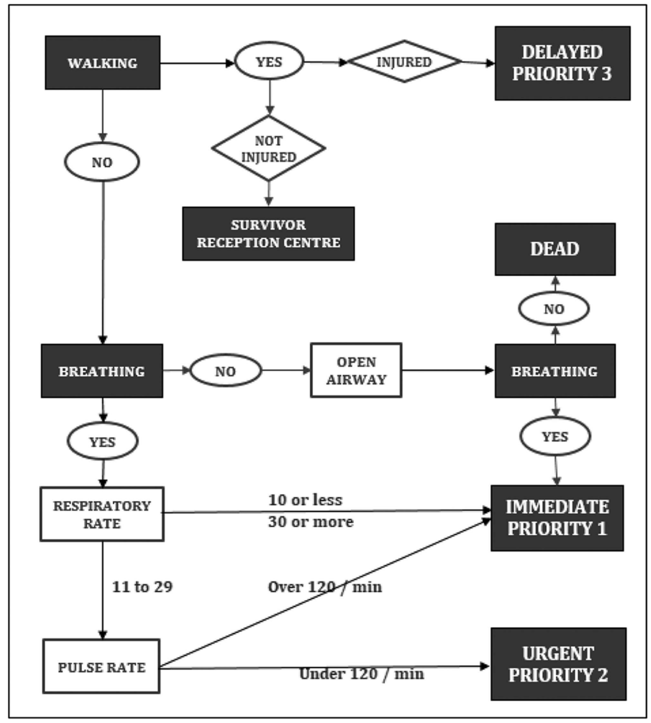


**Figure 1.** Triage Sieve Algorithm.

Prehospital health care providers in South Africa are divided into three groups according to training levels: Basic Life Support (BLS) practitioners (entry-level emergency care providers); Intermediate Life Support (ILS) practitioners (mid-level emergency care providers); and Advanced Life Support (ALS) practitioners or paramedics (advanced-level emergency care providers).

### *Study Population*

There are 1,510 prehospital emergency care providers in the Western Cape government health service: 614 BLS, 644 ILS, and 252 ALS (E-mail; H. Hendricks, Manager EMS Information Management; February 12, 2018). All providers attending MIMMS training in the Western Cape from March through October 2016 were eligible to participate. The Western Cape is the southernmost of South Africa's nine provinces, covering an area of 129,462 km$^2$ with a population of 6.5 million.[21] It is divided into five rural districts (Cape Winelands, Central Karoo, Eden, Overberg, and West Coast) and one metropolitan district (City of Cape Town).[22]

Inclusion criteria were prehospital health care providers registered with the Health Professions Council of South Africa (Pretoria, South Africa) and practicing in South Africa. Trainers of major-incident courses were excluded.

### *Data Collection*

Twenty different multiple-choice questions were created before the start of the study and consisted of structured case scenarios (vignettes) with casualties from a fabricated major incident requiring triage. These questions were validated by an expert panel consisting of five emergency medicine physicians considered to be experts based on their knowledge, training, and experience in prehospital medicine in South Africa, and specifically in the use of the Triage Sieve algorithm. The experts independently assigned a triage category to the patient in each vignette. The same triage category (100% agreement) was assigned in 16 questions. The remaining four questions were subsequently discussed and the correct answer decided by consensus agreement. The validated questions (Appendix 1; available online only) were used to determine the triage accuracy.

All attendees were informed about the study at the start of the MIMMS training. Consented participants were allocated a random identification number before completing a basic demographic questionnaire (Appendix 2; available online only) and a pre-training written test consisting of 20 multiple-choice questions.

After the formal major-incident training, which included the Triage Sieve algorithm, participants completed a written post-training test (consisting of 20 multiple-choice questions) and a face-to-face evaluation. Additional pressure was placed on the trainee during the face-to-face evaluation. Trainees were individually assessed by one trainer who randomly selected any three of the validated questions and presented it to the trainee as a patient requiring triage. The time from when the scenario was presented to when the trainee allocated a triage category was noted for each of the three selected cases. The Triage Sieve algorithm was displayed during all the tests.

The same course trainers were used throughout the data collection period to reduce bias. Providers not participating in the study received the same standard of teaching. The first MIMMS course during the data collection period was used as a pilot study in order to improve the process for the participants, the MIMMS trainers, and the data collectors. Data from the pilot study were not included in the data analysis.

Two outcomes were measured to assess participants' mass-casualty triage performance: (1) triage accuracy and (2) duration of triage. Triage accuracy was measured by comparing the participant's answer to the validated answers of the expert group. The results are presented as percentage of correct triage, over-triage, and under-triage. The duration of triage was considered the total time for completing triage during the face-to-face evaluation.

*Data Management*

Test sheets were marked by the lead investigator (AAN). A second examiner who had no medical training and who did not participate in any other part of the study crosschecked the marks. Data were subsequently cleaned, entered into a Microsoft Excel spreadsheet Version 2013 (Microsoft Corporation; Redmond, Washington USA), and then exported for analysis to STATA 14 (StataCorp. 2015; College Station, Texas USA). Data entering was again checked for completion by the second examiner. Data were kept in an access-controlled location.

*Data Analysis*

Standard descriptive statistics are presented. Means and standard deviations or medians and interquartile ranges were used to describe continuous variables. Categorical data are described using frequencies or percentage with 95% confidence intervals, where appropriate. Chi-square and Fisher exact tests were used to compare basic demographics between groups. For the primary

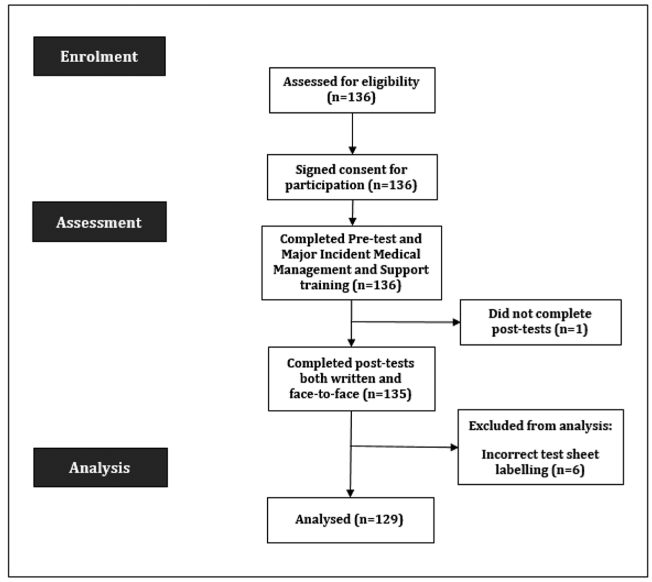


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**Figure 2.** Flow Chart of the Study Population.

outcome (overall accuracy scores), one-way ANOVA or logistic regression, where appropriate, was performed to determine significant differences between providers. A 5.0% significance level was applied. Normality was checked both quantitatively and qualitatively.

**Results**

A total of 136 participants attended the MIMMS during the data collection period and all were recruited for the study. Only data from 129 participants were analyzed after seven were excluded (Figure 2).

Study participants had a similar gender distribution (male n = 65; 50.4%) with a mean age of 33.4 years (standard deviation (SD) 7.77 years). Most of the participants (n = 87; 67.4%) were BLS providers. A total of 72 (55.8%) participants were working in the rural areas of the Western Cape, while 80 (62.0%) participants had worked for the provincial government EMS for less than five years. Only 41 (31.8%) of the participants reported having prior major-incident training, including Triage Sieve protocol, while 17 (13.2%) of those having been trained five years or more before the study (Table 1).

The overall correct triage score pre-training was 53.9% (95% CI, 51.98 to 55.83), over-triage was 31.4% (95% CI, 29.66 to 33.2), and under-triage was 13.8%( 95% CI, 12.55 to 12.22). After training, the overall correct triage score increased to 63.6% (95% CI, 61.72 to 65.44), over-triage decreased to 17.9% (95% CI, 16.47 to 19.43), and under-triage increased to 17.8% (95% CI, 16.40 to 19.36; Figure 3).

The ALS providers had the highest percentage of correct triage scores both pre- and post-training, with the lowest rates of over- and under-triage (Table 2).

There was no difference in triage scores across the different age groups (P = .229). However, participants who previously received major-incident training performed better compared to those with no prior training (P = .001).

The duration of triage (median; interquartile range) was the shortest for ALS providers (three seconds; two to seven seconds), followed by BLS (four seconds; two to eight seconds) and ILS (five seconds; three to nine seconds; P = .034).

| | BLS n (%) | ILS n (%) | ALS n (%) | TOTAL n (%) |
|---|---|---|---|---|
| **Total** | 87 (67.44) | 22 (7.05) | 20 (15.50) | 129 (100.00) |
| **Gender** | | | | |
| Male | 43 (33.33) | 12 (9.30) | 10 (7.75) | 65 (50.39) |
| Female | 44 (34.11) | 10 (7.75) | 10 (7.75) | 64 (49.61) |
| **Age: Mean (SD)** | 33.58 (6.94) | 33.05 (8.24) | 33 (7.58) | 33.14 (7.77) |
| **Area of Service** | | | | |
| Rural | 53 (41.09) | 11 (8.53) | 8 (6.20) | 72 (55.81) |
| Urban | 31 (24.03) | 10 (7.75) | 7 (5.43) | 48 (37.21) |
| Did Not Answer | | | | 9 (6.98) |
| **Duration of Service** | | | | |
| < 5 Years | 61 (47.29) | 12 (9.30) | 7 (5.43) | 80 (62.02) |
| ≥ 5 Years | 24 (18.60) | 10 (7.75) | 13 (10.08) | 47 (36.43) |
| Did Not Answer | | | | 2 (1.55) |
| **Prior Major-Incident Training** | | | | |
| < 5 Years | 12 (9.31) | 8 (6.21) | 4 (3.10) | 24 (18.6) |
| ≥ 5 Years | 9 (6.98) | 2 (1.55) | 6 (4.65) | 17 (13.18) |
| Not Trained | 64 (49.61) | 10 (7.75) | 8 (6.20) | 82 (63.57) |
| Did Not Answer | | | | 6 (4.65) |



**Table 1**. Demographics of Participants Divided According to Training Level
Abbreviations: ALS, Advanced Life Support; BLS, Basic Life Support; ILS, Intermediate Life Support.

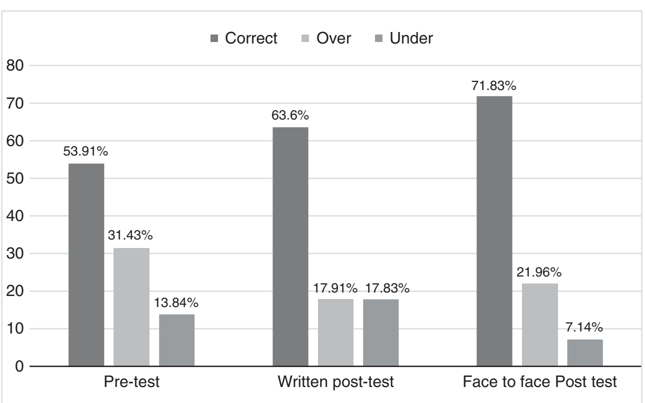




**Figure 3.** Triage Accuracy for All Study Participants Using the Triage Sieve Algorithm.

## Discussion

This is the first study to compare triage accuracy and duration between different levels of prehospital health care providers in South Africa using the Triage Sieve algorithm. The overall correct score post-major-incident training was a mere 64.0%. There were no significant differences in triage accuracy between the different levels of providers after training, although ALS providers were more likely to perform the triage correctly (odds ratio 1.21). The duration of triage was also not clinically significant between the different levels of providers. Previous major-incident training made a substantial difference in triage performance (P = .001).

The overall correct triage score of 64.0% across all levels of prehospital providers is disconcertingly low. Risavi, et al found scores of 75.0% across all levels of paramedics, another study found 84.0% accuracy amongst paramedics,[23] while another found 79.9% for primary care paramedic trainees and 72.0% for fire service trainees.[24] However, a 10.0% improvement in triage scores was noted after providers underwent the MIMMS training. This trend of improvement post-training is similar to findings in other studies. Sapp, et al described that first-year medical students who received brief START training had comparable triage performance to qualified nurses, paramedics, and emergency physicians.[25] Another study found similar triage scores in primary care paramedic and fire science students after training. Despite this trend towards improvement, the low correct scores are concerning for a country with high numbers of major incidents.[17]

Triage error rates varied from previous studies. Over-triage rate was similarly <50.0% while under-triage rate was 3.6 times higher than the recommended <5.0%.[26,27] Other studies show diverse findings with no noticeable trend. In a Dutch study, under-triage occurred in 10.9% (95% CI, 7.4 to 15.7) of cases with over-triage being 39.5% (95% CI, 36.9 to 42.1).[11] While in a retrospective



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| | Training Level | Correct Triage | | Over-Triage | | Under-Triage | |
|---|---|---|---|---|---|---|---|
| | | Score (%) | Odds Ratio (95%CI) | Score (%) | Odds Ratio (95%CI) | Score (%) | Odds Ratio (95%CI) |
| Pre-MIMMS Training | BLS | 51 | 1 | 35 | 1 | 13 | 1 |
| | ILS | 53 | 1.07 (0.87 to 1.32) | 29 | 0.75 (0.60 to 0.95) | 18 | 1.48 (1.11 to 1.97) |
| | ALS | 65 | 1.79 (1.43 to 2.25) | 20 | 0.43 (0.33 to 0.56) | 15 | 1.28 (0.94 to 1.74) |
| Post- MIMMS Training | BLS | 63 | 1 | 19 | 1 | 17 | 1 |
| | ILS | 63 | 1.01 (0.82 to 1.26) | 19 | 0.98 (0.75 to 1.28) | 18 | 1.01 (0.77 to 1.34) |
| | ALS | 68 | 1.21 (0.96 to 1.53) | 11 | 0.55 (0.39 to 0.76) | 21 | 1.23 (0.94 to 1.62) |



**Table 2.** Comparison of Written Triage Scores between Differently Trained Prehospital Health Care Providers Using the Triage Sieve Algorithm
Abbreviations: ALS, Advanced Life Support; BLS, Basic Life Support; ILS, Intermediate Life Support; MIMMS, Major Incident Medical Management and Support.

study of the Turkish Airline crash, of the 135 victims triaged by ambulance teams, there was an over-triage rate of 89.0% and under-triage rate of 12.0%.[12,13]

When comparisons were made between the various qualifications, ALS providers had the highest correct triage scores with the lowest over-triage rates. This is inconsistent with other studies which showed better performance and algorithm adherence rates by the least-qualified levels of prehospital providers compared to the most advanced. Fitzharris, et al in their New South Wales protocol adherence study found variations in performance across the different levels of prehospital personnel with highest adherence rates (77.0%) among the lowest-level trained personnel.[14] A Dutch study on protocol adherence by EMS personnel in triaging 1,607 victims of high-energy impact trauma found adherence rate of 78.7% (310 patients were not transported to the required level trauma center).[11] Similar findings of protocol non-adherence were reported by Wong, et al in their Hong Kong study assessing appropriate diversion of 141 major trauma cases by paramedics. Over-diversion rate was 3.5% with under-diversion at 40.5%; overall accuracy was 74.5%.[15]

There were no substantial differences in triage scores between different provider levels after receiving formal major-incident training. It is interesting to note that while they generally performed better, there was no significant improvement in the triage accuracy by the ALS providers pre- and post-training (65.0% to 68.0%) compared to both ILS (53.0% to 63.0%) and BLS (51.0% to 63.0%). The reason for this was not explored.

Prior major-incident training was found to be an independent factor contributing to better performance. This was not the case in similar studies amongst firemen and other prehospital providers where prior training did not make any statistical difference.[28,29]

## Limitations

*Limitations*

The study had several limitations potentially influencing the generalizability of the results. Firstly, the tests were completed in a controlled environment. While the post-training, face-to-face evaluation was introduced to simulate additional pressure, it still lacks the multiple external factors and realism of a real major incident. Secondly, major-incident training is not compulsory for all prehospital personnel. This introduced selection bias as participants interested in major incidents were most likely to attend the MIMMS course. Findings might therefore not reflect the entire EMS system. Lastly, only one province was included and care should be taken in extrapolating the results to the rest of South Africa or other EMS systems.

*Suggestions for Future Research*

Prior major-incident training was an important factor and more research is needed to determine adequate follow-up training. The triage performance of non-health care personnel that would respond to major incidents (eg, fire, traffic, and police) should also be evaluated to determine whether they might be more suitable to perform primary triage.

## Conclusion

The ability of all levels of prehospital emergency care providers in South Africa's state-owned EMS system to correctly use the Triage Sieve algorithm is less than optimal. Although accuracy improved after formal major-incident training, there was no substantial difference between the three provider levels. The ALS providers performed the triage quicker than the other groups, but this difference was not clinically significant. The BLS and ILS providers with major-incident training can thus be utilized for primary major-incident triage, allowing ALS providers to take on more clinically orientated roles. Prior major-incident training made a significant difference in triage accuracy.

## Supplementary Material

To view supplementary material for this article, please visit https://doi.org/10.1017/S1049023X18000699

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