ORIGINAL ARTICLE UDK: 616-001-083.98-036.88

www.doi.org/10.67214/3kpwbk66

# EVALUATION OF RAPID TRAUMA SCORING SYSTEMS FOR PREDICTING IN-HOSPITAL MORTALITY IN POLYTRAUMA PATIENTS ADMITTED TO AN EMERGENCY CENTER

**Stanoeva J.[1], Brzanov N.[1], Gavrilovski A.[1], Matveeva N.[2], Levova O.[3], Gavrilovska-Brzanov A.[1]**

*[1] University Clinic for Traumatology, Orthopedic diseases, Anesthesia and Resuscitation, Intensive care and Emergency Center, Faculty of Medicine, Ss. Cyril and Methodius University, Skopje, North Macedonia*

*[2] University "Ss. Cyril and Methodius", Medical faculty – Skopje, Institute for Anatomy*

*[3]PHI General Hospital Kavadarci*

## Abstract

**Objective:** Polytrauma remains a major cause of mortality and disability worldwide and requires rapid risk stratification during the early phase of emergency care. Simple physiological trauma scoring systems, such as the New Trauma Score (NTS), Glasgow Coma Scale, Age and Systolic Blood Pressure score (GAP), and Mechanism, Glasgow Coma Scale, Age and Arterial Pressure score (MGAP), may support early triage and prediction of adverse outcomes.

This study aimed to evaluate and compare the predictive accuracy of NTS, GAP, and MGAP scores for in-hospital mortality in polytrauma patients admitted to the Emergency Center.

**Materials and Methods:** A single-center retrospective-prospective observational cohort study was conducted at the University Emergency Surgical Center in Skopje from January 2024 to November 2025. A total of 65 polytrauma patients who met the inclusion criteria were analyzed. Demographic characteristics, mechanism of injury, Glasgow Coma Scale (GCS), systolic blood pressure, peripheral oxygen saturation, and in-hospital outcome were recorded at admission. NTS, GAP, and MGAP scores were calculated and compared for their ability to predict in-hospital mortality using receiver operating characteristic (ROC) curve analysis.

**Results:** Among 65 patients, 57 were male and 8 were female. Forty-nine patients survived, while 16 patients died during hospitalization. Mortality was higher among patients aged ≥60 years and among those with lower initial GCS scores.

All three scoring systems demonstrated excellent diagnostic accuracy for predicting in-hospital mortality, with area under the curve (AUC) values above 0.90. MGAP showed the highest predictive accuracy (AUC = 0.94), followed by GAP (AUC = 0.93) and NTS (AUC = 0.91).

**Conclusion:** NTS, GAP, and MGAP are simple and rapidly applicable scoring systems with excellent predictive accuracy for in-hospital mortality in polytrauma patients. MGAP showed the highest AUC value in this cohort, likely due to the additional inclusion of injury mechanism. However, because the performance of all three scores was excellent and closely comparable, they may all be considered useful tools for early risk stratification and triage in emergency center settings.

***Keywords:*** *emergency center; GAP score; in-hospital mortality; polytrauma; trauma scoring systems.*

## Introduction

Polytrauma, defined as significant injury involving two or more body regions or organ systems, represents a major challenge in emergency medicine and remains a leading cause of mortality and disability, particularly among younger patients (1). Globally, injuries account for a substantial proportion of preventable deaths, with road traffic accidents, falls, occupational injuries, and violence-related trauma representing important mechanisms of severe injury (2).

The initial period after trauma, often referred to as the "golden hour," is critical for patient outcome. During this period, rapid assessment, early recognition of life-threatening injuries, appropriate triage, and timely initiation of treatment may significantly reduce morbidity and mortality (3). In emergency settings, clinicians therefore need simple, rapid, and reliable tools that can identify patients at high risk of deterioration or death during the first minutes after admission.

Several trauma scoring systems have been developed to quantify injury severity and predict outcome. Anatomical and combined scoring systems, such as the Injury Severity Score (ISS), Trauma and Injury Severity Score (TRISS), and Revised Trauma Score (RTS), have shown prognostic value, but some require detailed anatomical diagnosis or additional information that may not be immediately available during the primary survey (3,4). This limits their practical use for early triage, particularly in busy emergency departments or lower-resource settings where rapid decision-making is essential (5,6).

Simplified physiological trauma scores have become increasingly important in the initial assessment of trauma patients. These scores are based on parameters that are readily available at admission, including the Glasgow Coma Scale (GCS), systolic blood pressure, age, oxygen saturation, and mechanism of injury. Recent comparative studies have assessed the Glasgow Coma Scale, Age and Systolic Blood Pressure score (GAP), the Mechanism, Glasgow Coma Scale, Age and Arterial Pressure score (MGAP), and other rapid trauma scores for predicting mortality in trauma patients (7).

The New Trauma Score (NTS), a modification of the Revised Trauma Score, incorporates peripheral oxygen saturation instead of respiratory rate and has demonstrated good predictive performance for trauma mortality (8). Subsequent studies have also evaluated the accuracy of GAP, MGAP, and NTS in trauma populations, supporting their use as simple tools for early risk stratification (9). Although these scoring systems are simple and clinically applicable, their predictive performance may vary across different trauma populations and healthcare settings. Therefore, local validation is important before their routine implementation in a specific emergency center setting.

The aim of this study was to evaluate and compare the predictive accuracy of NTS, GAP, and MGAP scores for predicting in-hospital mortality in polytrauma patients admitted to the Emergency Center. In addition, the study assessed the association of age, mechanism of injury, and initial neurological status, evaluated by GCS, with treatment outcome. By comparing the diagnostic performance of these scores using receiver operating characteristic curve analysis, this study aimed to identify a simple and reliable tool for early risk stratification of high-risk polytrauma patients in our clinical setting.

## Materials and Methods

### Study design and setting

This was a single-center observational cohort study conducted at the University Emergency Surgical Center in Skopje, North Macedonia, between January 2024 and November 2025. The study included patients admitted to the Emergency Center after severe trauma or polytrauma requiring urgent evaluation and treatment.

All patients were assessed immediately after admission according to standard trauma protocols, including primary survey, clinical examination, available medical history, and non-invasive monitoring. Initial management was performed according to the ABCDE approach.

### Study population

A total of 65 patients with polytrauma who met the inclusion criteria were included in the analysis. Polytrauma was defined as severe injury involving two or more body regions or organ systems, associated with potential or actual life-threatening physiological impairment. Patients were included if they were older than 15 years and admitted to the Emergency Center with severe trauma or polytrauma requiring urgent assessment and treatment. Both blunt and penetrating mechanisms of injury were included, such as road traffic accidents, pedestrian injuries, workplace injuries, falls from height, crush or blast injuries, stab wounds, gunshot injuries, and other severe traumatic mechanisms.

Patients were excluded if they had no signs of life on arrival, had insufficient data required for calculation of the trauma scores, were younger than 15 years, were pregnant, had drowning-related injury, or had been initially treated in another institution before referral to the tertiary center. Patients who left the Emergency Center before completion of emergency evaluation were also excluded.

## Initial assessment and data collection

Upon admission, all patients were managed according to the standard ABCDE trauma approach. Airway, breathing, circulation, neurological status, and exposure were assessed during the primary survey. Non-invasive monitoring, including systolic blood pressure, heart rate, electrocardiographic monitoring, and peripheral oxygen saturation, was established immediately after admission.

Data were collected from trauma score sheets, emergency medical records, the institutional electronic health record system, and medical documentation. The following variables were recorded at admission: age, sex, mechanism of injury, Glasgow Coma Scale (GCS), systolic blood pressure, peripheral oxygen saturation, and in-hospital outcome.

In patients with impaired consciousness or inability to provide history, information regarding the mechanism and circumstances of injury was obtained from emergency medical personnel, witnesses, family members, or available medical documentation.

The primary outcome was in-hospital mortality, defined as death during hospital stay. Patients were followed until hospital discharge or death.

## Trauma scoring systems

The New Trauma Score (NTS), Glasgow Coma Scale, Age and Systolic Blood Pressure score (GAP), and Mechanism, Glasgow Coma Scale, Age and Arterial Pressure score (MGAP) were calculated at admission using the initial physiological parameters recorded during emergency assessment.

The GCS was used to assess the initial level of consciousness, with values ranging from 3 to 15. Patients were classified as having severe impairment of consciousness when GCS was 3–8, moderate impairment when GCS was 9–12, and mild or no impairment when GCS was 13–15.

NTS, GAP, and MGAP were calculated at admission according to their published definitions. Patients were categorized into risk groups according to previously published cut-off values for each scoring system, as shown in Table 1.

**Table 1.** Components and risk categories of the trauma scoring systems

| ***Scoring system*** | ***Components*** | ***Risk categories used in the study*** |
|---|---|---|
| *NTS* | GCS, systolic blood pressure, peripheral oxygen saturation | Low risk: 18–23; intermediate risk: 12–17; high risk: 6–11; very high risk: 3–5 |
| *GAP* | GCS, age, systolic blood pressure | Low risk: 19–24; moderate risk: 11–18; high risk: <11 |
| *MGAP* | Mechanism of injury, GCS, age, systolic blood pressure | Low risk: 23–29; moderate risk: 18–22; high risk: <18 |

*****NTS: New Trauma Score; GAP: Glasgow Coma Scale, Age and Systolic Blood Pressure score; MGAP: Mechanism, Glasgow Coma Scale, Age and Arterial Pressure score; GCS: Glasgow Coma Scale.

Ethical considerations

Patient data were analyzed anonymously and used exclusively for the purposes of this study. The study was approved by the Institutional Review Board of the Faculty of Medicine, University "Ss. Cyril and Methodius", Skopje, Republic of North Macedonia.

Written informed consent was obtained from patients when possible. In patients with impaired consciousness or inability to provide consent, consent was obtained from a close family member or legally authorized representative according to institutional practice.

Statistical analysis

Statistical analysis was performed using SPSS version 27.0 (IBM Corp., Armonk, NY, USA). The normality of data distribution was assessed using the Shapiro–Wilk test. Categorical variables were presented as frequencies and percentages. Comparisons between survivors and non-survivors were performed using the $\chi^2$ test or Fisher's exact test, as appropriate.

Spearman's correlation was used to evaluate associations between trauma scoring systems. Receiver operating characteristic (ROC) curve analysis was performed to assess the diagnostic accuracy of NTS, GAP, and MGAP for predicting in-hospital mortality. The area under the curve (AUC) with 95% confidence intervals was calculated for each scoring system. A p-value $<0.05$ was considered statistically significant.

## Results

Patient characteristics and clinical outcome

A total of 65 polytrauma patients who met the inclusion criteria were included in the study. Of these, 57 patients were male (87.7%) and 8 were female (12.3%). Forty-five patients (69.2%) were aged 15–59 years, while 20 patients (30.8%) were aged 60 years or older.

Blunt trauma was the predominant mechanism of injury and was present in 58 patients (89.2%), while penetrating trauma was recorded in 7 patients (10.8%).

According to in-hospital outcome, 49 patients survived (75.4%), while 16 patients died during hospitalization (24.6%). Mortality was higher among patients aged ≥60 years compared with younger patients: 8 of 20 patients aged ≥60 years died (40.0%), compared with 8 of 45 patients aged 15–59 years (17.8%).

Initial level of consciousness, assessed using the Glasgow Coma Scale (GCS), was strongly associated with in-hospital mortality. Among patients with severe impairment of consciousness (GCS 3–8), 9 of 12 patients died (75.0%). Among patients with moderate impairment of consciousness (GCS 9–12), 6 of 12 patients died (50.0%). In contrast, only 1 of 41 patients with GCS 13–15 died (2.4%) ($p < 0.001$).

**Table 2.** Baseline characteristics and in-hospital outcome of polytrauma patients

| Variable | **Total n (%)** | **Survivors n (%)** | **Non-survivors n (%)** | **p-value** |
|---|---|---|---|---|
| **Total** | 65 (100) | 49 (75.4) | 16 (24.6) | — |
| **Sex** | | | | 0.668 |
| Male | 57 (87.7) | 42 (73.7) | 15 (26.3) | |
| Female | 8 (12.3) | 7 (87.5) | 1 (12.5) | |
| **Age group** | | | | 0.068 |
| 15–59 years | 45 (69.2) | 37 (82.2) | 8 (17.8) | |

| | | | | |
|---|---|---|---|---|
| ≥60 years | 20 (30.8) | 12 (60.0) | 8 (40.0) | |
| **Mechanism of injury** | | | | 0.671 |
| Blunt trauma | 58 (89.2) | 43 (74.1) | 15 (25.9) | |
| Penetrating trauma | 7 (10.8) | 6 (85.7) | 1 (14.3) | |
| **GCS category** | | | | <0.001 |
| GCS 3–8 | 12 (18.5) | 3 (25.0) | 9 (75.0) | |
| GCS 9–12 | 12 (18.5) | 6 (50.0) | 6 (50.0) | |
| GCS 13–15 | 41 (63.1) | 40 (97.6) | 1 (2.4) | |

Note**:** Percentages for survivors and non-survivors are calculated within each category.

*GCS: Glasgow Coma Scale.

Mortality according to trauma scoring systems

The initial NTS, GAP, and MGAP risk categories differed significantly between survivors and non-survivors.

According to the NTS classification, 43 patients were categorized as low risk, of whom 1 patient died (2.3%). Fourteen patients were categorized as intermediate risk, of whom 9 died (64.3%). Six patients were categorized as high risk, of whom 4 died (66.7%), while both patients in the very high-risk group died (100%) ($p < 0.001$).

According to the GAP score, none of the 39 patients in the low-risk group died. Among 19 patients in the moderate-risk group, 10 died (52.6%), while among 7 patients in the high-risk group, 6 died (85.7%) ($p < 0.001$).

According to the MGAP score, none of the 39 patients in the low-risk group died. Among 17 patients in the moderate-risk group, 8 died (47.1%), while among 9 patients in the high-risk group, 8 died (88.9%) ($p < 0.001$).

**Table 3.** Mortality according to NTS, GAP, and MGAP risk categories

| Scoring system / risk category | **Total n** | **Survivors n (%)** | **Non-survivors n (%)** | **p-value** |
|---|---|---|---|---|
| **NTS** | | | | <0.001 |
| Low risk | 43 | 42 (97.7) | 1 (2.3) | |
| Intermediate risk | 14 | 5 (35.7) | 9 (64.3) | |
| High risk | 6 | 2 (33.3) | 4 (66.7) | |
| Very high risk | 2 | 0 (0.0) | 2 (100.0) | |

| | | | | |
|---|---|---|---|---|
| **GAP** | | | | <0.001 |
| Low risk | 39 | 39 (100.0) | 0 (0.0) | |
| Moderate risk | 19 | 9 (47.4) | 10 (52.6) | |
| High risk | 7 | 1 (14.3) | 6 (85.7) | |
| **MGAP** | | | | <0.001 |
| Low risk | 39 | 39 (100.0) | 0 (0.0) | |
| Moderate risk | 17 | 9 (52.9) | 8 (47.1) | |
| High risk | 9 | 1 (11.1) | 8 (88.9) | |

Note**:** Percentages are calculated within each risk category. NTS: New Trauma Score; GAP: Glasgow Coma Scale, Age and Systolic Blood Pressure score; MGAP: Mechanism, Glasgow Coma Scale, Age and Arterial Pressure score.

Correlation between trauma scoring systems

Spearman correlation analysis demonstrated strong associations between the evaluated trauma scoring systems. NTS showed a strong positive correlation with GAP (rho = 0.796, $p < 0.001$) and MGAP (rho = 0.758, $p < 0.001$), while GAP and MGAP demonstrated a very strong positive correlation (rho = 0.944, $p < 0.001$).

The categorized GCS variable showed a negative correlation with NTS, GAP, and MGAP because higher GCS category codes represented more severe impairment of consciousness.

This confirms that worsening neurological status was associated with lower trauma score values and higher mortality risk.

**Table 4.** Spearman correlation between GCS category and trauma scoring systems

| Variable | GCS category* | NTS | GAP | MGAP |
|---|---|---|---|---|
| GCS category* | 1.000 | -0.945** | -0.746** | -0.710** |
| NTS | -0.945** | 1.000 | 0.796** | 0.758** |
| GAP | -0.746** | 0.796** | 1.000 | 0.944** |
| MGAP | -0.710** | 0.758** | 0.944** | 1.000 |

**Note:** **p < 0.001. GCS category was coded according to severity of consciousness impairment, with higher category values indicating more severe neurological impairment. GCS: Glasgow Coma Scale; NTS: New Trauma Score; GAP: Glasgow Coma Scale, Age and Systolic Blood Pressure score; MGAP: Mechanism, Glasgow Coma Scale, Age and Arterial Pressure score.

Diagnostic accuracy for prediction of in-hospital mortality

The diagnostic performance of NTS, GAP, and MGAP for predicting in-hospital mortality was evaluated using receiver operating characteristic (ROC) curve analysis (Figure 1).

All three scoring systems demonstrated excellent diagnostic accuracy, with area under the curve (AUC) values above 0.90. The highest predictive accuracy was observed for MGAP, with an AUC of 0.94 (95% CI: 0.82–0.99). GAP showed a similar predictive performance, with an AUC of 0.93 (95% CI: 0.86–0.99), while NTS also demonstrated excellent accuracy, with an AUC of 0.91 (95% CI: 0.88–0.99).

These findings indicate that all three scoring systems were highly effective in discriminating between survivors and non-survivors, with MGAP showing the strongest overall performance.

**Figure 1.** Receiver operating characteristic curves of NTS, GAP, and MGAP for predicting in-hospital mortality.

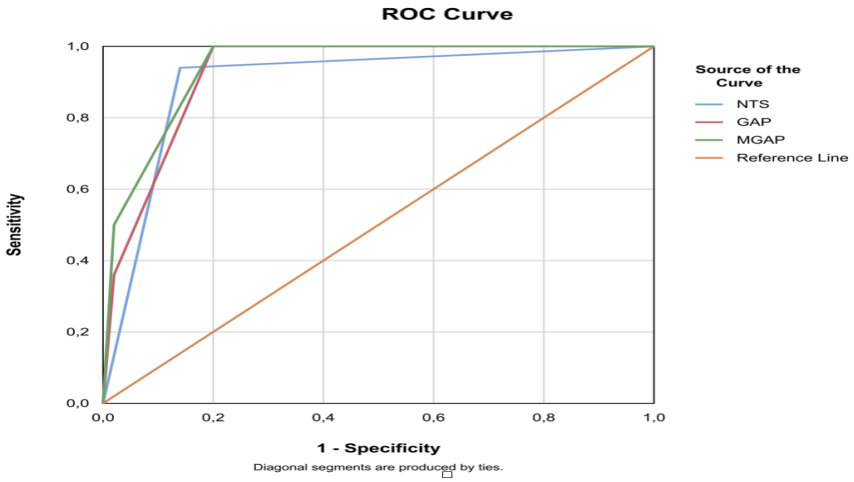


**Table 5.** Diagnostic accuracy of NTS, GAP, and MGAP for predicting in-hospital mortality

| Scoring system | AUC | 95% CI | Diagnostic performance |
|---|---|---|---|
| **MGAP** | 0.94 | 0.82–0.99 | Excellent |
| **GAP** | 0.93 | 0.86–0.99 | Excellent |
| **NTS** | 0.91 | 0.88–0.99 | Excellent |

Note**:** AUC: area under the receiver operating characteristic curve; CI: confidence interval; NTS: New Trauma Score; GAP: Glasgow Coma Scale, Age and Systolic Blood Pressure score; MGAP: Mechanism, Glasgow Coma Scale, Age and Arterial Pressure score.

**Discussion**

The present study evaluated the predictive accuracy of three rapid physiological trauma scoring systems — NTS, GAP, and MGAP — for in-hospital mortality in polytrauma patients admitted to a single Emergency Center. The main finding was that all three scoring systems demonstrated excellent discriminatory ability, with AUC values above 0.90. MGAP showed the numerically highest AUC value, followed closely by GAP and NTS. These findings are consistent with previous comparative studies showing that simple physiological trauma scores can accurately predict mortality in trauma patients (1,3,7,9). However, because the differences between AUC values in our study were small and no formal

statistical comparison between ROC curves was performed, the observed advantage of MGAP should be interpreted with caution.

In this cohort, in-hospital mortality was 24.6%, reflecting the severity of the included trauma population. This rate may be explained by the fact that the study included patients with severe trauma or polytrauma admitted to an emergency surgical center.

Previous studies have shown that the performance of trauma scoring systems depends on patient selection, injury severity, prehospital care, transport time, and healthcare system organization (3,5). Therefore, local validation of trauma scores is important before their routine implementation in a specific emergency center setting.

Initial neurological status was strongly associated with in-hospital mortality in our study. Mortality was highest among patients with severe impairment of consciousness: 75.0% of patients with GCS 3–8 died, compared with 50.0% of patients with GCS 9–12 and only 2.4% of patients with GCS 13–15. This finding confirms the central prognostic role of GCS in trauma patients. Since GCS is included in NTS, GAP, and MGAP, its strong association with mortality partly explains the excellent performance of all three scores. Previous studies on GAP and MGAP also emphasize GCS as one of the key components for early trauma mortality prediction (10,11).

Older patients showed higher mortality in our cohort, although the difference did not reach statistical significance.

Mortality among patients aged ≥60 years was 40.0%, compared with 17.8% among younger patients. This trend is clinically relevant and is consistent with previous trauma literature showing that advanced age contributes to poorer outcomes because of reduced physiological reserve, comorbidities, and lower tolerance to hemorrhage, hypoxia, traumatic brain injury,

and shock. The inclusion of age in both GAP and MGAP supports its prognostic value in early trauma assessment (10,11).

The MGAP score demonstrated the numerically highest predictive accuracy in our study, with an AUC of 0.94. This finding is consistent with the original study by Sartorius et al., who introduced MGAP as a simple prehospital triage score for predicting mortality in trauma patients (10).

The potential advantage of MGAP may be related to the inclusion of injury mechanism in addition to GCS, age, and systolic blood pressure. In polytrauma patients, mechanism of injury provides important contextual information regarding the expected severity and pattern of injuries. Similar findings have been reported in studies comparing MGAP with other trauma scoring systems, where MGAP demonstrated strong predictive performance for mortality (1,3,7,11).

The GAP score also demonstrated excellent performance, with an AUC of 0.93. This finding is in line with the study by Kondo et al., who developed the GAP score as a simplified scoring system for predicting in-hospital mortality in emergency department trauma patients (12). The main strength of GAP is its simplicity, as it includes only three variables: GCS, age, and systolic blood pressure. These parameters are available immediately at admission, making the score suitable for early triage. In our study, GAP and MGAP showed a very strong positive correlation, indicating that both scores classify patients in a similar prognostic direction. Previous multicenter and comparative studies have also shown that GAP and MGAP have closely related performance in trauma mortality prediction (3,7,13).

The NTS score also showed excellent discriminatory ability, with an AUC of 0.91. Although this value was slightly lower than those of MGAP and GAP, its performance remained clinically strong. NTS is a modification of the Revised Trauma Score and replaces

respiratory rate with peripheral oxygen saturation, which may be more objective and easier to obtain during emergency assessment. Jeong et al. proposed the NTS and demonstrated that the use of oxygen saturation may improve trauma mortality prediction compared with traditional physiological scoring systems (8). Wang et al. also reported that NTS may be useful for predicting mortality in multiple trauma patients (14).

In our cohort, NTS successfully differentiated low-risk from higher-risk patients, with mortality increasing across NTS risk categories.

A clinically important finding of this study is that all three scoring systems identified low-risk patients with very low or no mortality. No deaths were recorded in the low-risk groups of GAP and MGAP, while only one death occurred in the NTS low-risk group. This has practical implications for triage and resource allocation. Previous studies have similarly suggested that low-risk categories of GAP and MGAP are associated with very low mortality and may help clinicians rapidly identify patients who are less likely to require immediate life-saving interventions (10,12,13).

From a practical perspective, our findings support the use of rapid physiological trauma scores in the Emergency Center setting. Anatomical scores such as ISS and combined models such as TRISS have established prognostic value, but they often require complete diagnostic evaluation and are not always available during the primary survey (4). In contrast, NTS, GAP, and MGAP can be calculated within minutes of admission using simple clinical and physiological parameters. This makes them particularly useful in busy emergency departments and in resource-limited settings where rapid decision-making is essential (3,5).

The findings of the present study are also relevant because trauma score performance may vary between populations and healthcare systems. Feldhaus et al. emphasized that the feasibility and applicability of trauma scoring systems in low- and middle-income countries

depend on data availability, workflow, and system organization (5). Similarly, studies conducted in low-resource settings have shown that simplified trauma scoring systems such as GAP and MGAP may be more practical than complex anatomical or combined models (3). Therefore, our results provide useful local evidence supporting the applicability of these scores in our emergency center.

This study has several limitations. First, it was conducted at a single center and included a relatively small sample of 65 patients, which may limit the generalizability of the findings. Second, the number of deaths was limited, which may affect the precision of AUC estimates and subgroup comparisons. Third, although MGAP showed the numerically highest AUC, formal statistical comparison between ROC curves was not performed; therefore, definitive superiority of one score over another cannot be concluded. Fourth, the study evaluated in-hospital mortality but did not include long-term outcomes, functional recovery, or neurological outcome after discharge. Fifth, although the scores were calculated from admission data, some variables may have been influenced by prehospital care, transport time, or early resuscitation before hospital arrival. Finally, this study did not compare rapid physiological scores with anatomical scores such as ISS or combined models such as TRISS, which could provide additional insight into their relative performance.

Despite these limitations, the study provides useful local evidence on the performance of rapid trauma scoring systems in polytrauma patients treated in an Emergency Center. The findings suggest that NTS, GAP, and MGAP are simple, rapidly applicable, and accurate tools for early mortality risk assessment. MGAP showed the numerically highest AUC value, while GAP and NTS demonstrated closely comparable excellent performance. Further larger, multicenter studies are needed to validate these findings and to determine whether

routine implementation of these scores can improve triage decisions, resource allocation, and patient outcomes.

## Conclusion

In this single-center cohort of polytrauma patients, NTS, GAP, and MGAP demonstrated excellent predictive accuracy for in-hospital mortality. MGAP showed the highest AUC value, followed closely by GAP and NTS, suggesting that all three scoring systems may be useful for early mortality risk assessment in the Emergency Center.

The findings confirm the importance of initial neurological status, age, systolic blood pressure, oxygen saturation, and mechanism of injury in early trauma prognosis. Because these variables are rapidly available at admission, NTS, GAP, and MGAP can support timely triage, early identification of high-risk patients, and more efficient allocation of emergency and intensive care resources.

Among the evaluated scores, MGAP showed the numerically strongest overall performance, likely due to the inclusion of injury mechanism. However, GAP and NTS also demonstrated excellent and closely comparable accuracy and may be valuable alternatives depending on data availability and clinical workflow.

## Declarations

*Ethics approval and consent to participate:* This study was approved by the Institutional Review Board of the Faculty of Medicine, University "Ss Cyril and Methodius", Skopje, Republic of North Macedonia (at the 9th regular session (Decision No.03-2987/8)

*Informed consent:* Written informed consent was obtained from patients when possible. In patients with impaired consciousness or inability to provide consent, consent was obtained

from a close family member or legally authorized representative according to institutional practice.

*Conflict of interest:* The authors report no financial or personal conflicts of interest.

*Funding*: This research received no external funding.

*Availability of data and materials:* The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

*Author Contributions:* Conceptualisation, J.S. and A.G.B.; methodology, N.M. and N.B.; investigation, J.S., A.G., N.B. and O.L.; data curation, J.S. and N.M.; writing – original draft preparation, J.S. and N.B.; writing – review and editing, J.S. and A.G.B..; supervision, A.G.B.; project administration, O.L.. All authors have read and agreed to the published version of the manuscript.

*Acknowledgments*: None

*Use of Artificial Intelligence (AI) tools:* The authors declare that no artificial intelligence tools were used in the preparation of this manuscript.

**References**:

1. Asadi P, Ziabari SMZ, Heydari F, Mohammadi P, Ehsani E, Roodsari NN. Comparison of MGAP, GAP, and RTS for Predicting Early Mortality in Multiple Trauma Patients. Eurasian J Emerg Med. 2023;22(4):216-22
2. World Health Organization. (19 june 2024). Injuries and violence https://www.who.int/news-room/fact-sheets/detail/injuries-and-violence
3. Mohammed Z, Saleh Y, AbdelSalam EM, Mohammed NBB, El-Bana E, Hirshon JM. Evaluation of the Revised Trauma Score, MGAP, and GAP scoring systems in

predicting mortality of adult trauma patients in a low-resource setting. BMC Emerg Med. 2022 May 28;22(1):90.

4. Orhon R, Eren SH, Karadayı S, et al. Comparison of trauma scores for predicting mortality and morbidity on trauma patients. TJTES. 2014;20(4):258–64.
5. Feldhaus I, Carvalho M, Waiz G, et al. Thefeasibility, appropriateness, and applicability of trauma scoring sys tems in low and middle-income countries: a systematic review. TSACO. 2020;5(1):e000424.
6. Zeinab M, Yaseen S, Eman Mohammed A, et al. Evaluation of the Revised Trauma Score, MGAP, and GAP scoring systems in predicting mortality of adult trauma patients in a lowresource setting BMC Emergency Medicine (2022) 22:90
7. Merchant AAH, Shaukat N, Ashraf N, et al. Which curve is better? A comparative analysis of trauma scoring systems in a South Asian country. Trauma Surg Acute Care Open. 2023 Nov 22;8(1):e001171.
8. Jeong JH, Park YJ, Kim DH, et al. The new trauma score (NTS): a modification of the revised trauma score for better trauma mortality prediction. BMC Surg. 2017 Jul 3;17(1):77.
9. Karajizadeh M. The Accuracy of GAP and MGAP Scoring Systems in Predicting Mortality in Trauma; a Diagnostic Accuracy Study. doi:10.22114/AJEM.V0I0.230
10. Sartorius D, Le Manach Y, David JS, et al. Mechanism, Glasgow Coma Scale, Age, and Arterial Pressure (MGAP): A new simple prehospital triage score to predict mortality in trauma patients. Critical Care Medicine, 2012; 40(4), 1171–1179.
11. Kimura A, Tanaka N. Usefulness of the MGAP scoring system in the prehospital setting to predict mortality in trauma patients: a systematic review and meta-analysis. Eur J Trauma Emerg Surg. 2019;45(5):847–55.

12. Kondo Y, Abe T, Kohshi K, Tokuda Y, Cook EF, Kukita I. Revised trauma scoring system to predict in-hospital mortality in the emergency department: Glasgow Coma Scale, Age, and Systolic Blood Pressure score. Critical Care, 2011;15(4), R191.
13. Kondo Y, Abe T, Kohshi K, Tokuda Y, Cook EF, Kukita I. Re-evaluation of the MGAP and GAP scoring systems in trauma patients: A multicenter study. Injury. 2016;47(6):1047–53.
14. Jeong JH, Park YJ, Kim DH, Kim TY, Kang C, Lee SH, Lee SB, Kim SC, Lim D. The new trauma score (NTS): a modification of the revised trauma score for better trauma mortality prediction. BMC Surg. 2017 Jul 3;17(1):77. doi: 10.1186/s12893-017-0272-4. PMID: 28673278.