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Field triage score (FTS) in battlefield casualties: validation of a novel triage technique in a combat environment

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Abstract

BACKGROUND: By the principles of Tactical Combat Casualty Care, battlefield casualties are preferentially triaged on the basis of pulse character and mental status. A weak or absent palpable pulse correlates with a systolic blood pressure (SBP) of ≤100 mm Hg. Furthermore, the motor component of the Glasgow Coma Scale (GCS-M) has been shown to correlate with outcomes. In a previous study, the authors developed a simple triage tool, the field triage score (FTS), on the basis of pulse character and GCS-M status, which provided a quick and effective means of predicting injury survival in the civilian trauma environment. The purpose of this analysis was to validate the predictive utility of the FTS in the battlefield trauma environment.

METHODS: The Joint Theater Trauma Registry was used to identify 4,988 battlefield casualties from Iraq and Afghanistan from January 2002 to September 2008 with requisite admission data elements of SBP, GCS-M status, and survival. SBP was stratified as ≤100 mm Hg, consistent with weak or absent pulse character, or >100 mm Hg, consistent with a normal pulse character. GCS-M status was stratified as either abnormal (<6) or normal (6). Casualties with presenting SBPs of 0 mm Hg were excluded from the analysis. As in the civilian trauma triage study, the FTS was derived by assigning a component value of 0 for weak or absent pulse or abnormal GCS-M status and a component value of 1 for either a normal pulse or normal GCS-M status. Adding the scores resulted in an aggregate FTS value of 0, 1, or 2.

RESULTS: For the overall population of 4,988 casualties, 87.5% (n = 4,366) had FTS of 2, with overall mortality of .1% (5 of 4,366). From the battlefield, 10.8% of patients (n = 540) presenting with FTS of 1 had a mortality rate that increased to 6.1% (33 of 540). In contrast, combat casualties presenting with FTS of 0 had a significantly higher mortality of 41.4% (34 of 82). The calculated lengths of stay were 6.1 (FTS 2), 9.2 (FTS 1), and 17.7 (FTS 0) days.

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CONCLUSION: This study has validated the utility of the FTS as a simple and practical triage instrument for use in the battlefield environment. Using the FTS, medics and medical providers will have a quick and effective measure to predict high-acuity combat casualties to triage evacuation and medical resources in austere military environments. This technique may have potential implications for domestic or foreign disaster or mass casualty situations in which supplies, medical resources, and facilities are limited.
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Many trauma triage scores have been proposed over the past several decades, but none has yet emerged as a gold standard. Each scoring system has benefits, and each has limitations. The impetus to derive an appropriate prehospital scoring system is based on the premise of getting a patient from the point of injury to the appropriate level of care while minimizing overtriage and undertriage. The prehospital triage scores used in the past take into account a number of physiologic variables, which are then used to predict outcomes.[1–13] Most of these triage tools are based on a patient's physiologic data, because it is assumed that the data are readily obtainable at the site of injury and therefore provide a possible snapshot of the patient's stability. The absence or inability to obtain physiologic measurements, especially in a mass casualty incident or a military environment, necessitates that prehospital providers make rapid decisions about priority of care, application of interventions, and transport destinations on the basis of isolated physiologic data points (eg, arterial pressure, heart rate, and respiratory rate) without the benefit of observing dynamic trends inherent to trauma physiology. Realizing these limitations, triage protocols have been developed for both civilian mass casualty incidents[14–16] and for combat settings.[17] The military environment is often characterized by lack of supplies and equipment, delayed or prolonged evacuation times and distances, devastating injuries, provider inexperience, and dangerous tactical situations.[18,19] Recent studies have determined that some physiologic values have a stronger association with an increased ability to predict patient mortality, particularly the motor component of the Glasgow Coma Scale (GCS-M), systolic blood pressure (SBP),[2,15,20–22] and the pulse character of the radial artery.[20,23] One study demonstrated that a weak radial pulse characteristic was correlated with SBP approximately ≤100 mm Hg, with concomitant mortality of 29%.[23] Seeking to provide evidence to support the triage algorithm on the basis of GCS-M status and the pulse character of the radial artery,[17,18] in a prior analysis based on a retrospective review from the National Trauma Data Bank, we developed the field triage score (FTS). This triage score was derived from SBP ≤100 mm Hg as a surrogate for pulse character and GCS-M status and correlated significantly with patient mortality. The present analysis was performed to validate the FTS in a battlefield environment.

Methods

The Joint Theater Trauma Registry was used to identify 4,992 battlefield casualties from Iraq and Afghanistan from January 2002 to September 2008 with requisite admission data elements of SBP, GCS-M status, length of stay, and survival. SBP was measured and recorded in the database and subsequently extrapolated as ≤100 mm Hg, consistent with weak or absent pulse character, or >100 mm Hg, consistent with a normal pulse character. GCS-M status was stratified as either abnormal (<6) or normal (6). Casualties with presenting SBPs of 0 mm Hg were excluded from the analysis. As in the civilian trauma triage study, the FTS was derived by assigning a component value of 0 for weak or absent pulse or abnormal GCS-M status and a component value of 1 for either a normal pulse or normal GCS-M status. Adding the scores resulted in an aggregate FTS value of 0, 1, or 2. An FTS was assigned to each record with valid GCS-M status and SBP in the Joint Theater Trauma Registry for analysis. FTS were analyzed for mortality and length-of-stay values in the studied population. Statistical analysis was performed on the comparison between score outcomes using SPSS version 11.0 (SPSS, Inc, Chicago, IL).

Results

For the overall population of 4,988 casualties, 87.5% (n = 4,366) had FTS of 2, with an overall mortality of .1% (5 of 4,366). From the battlefield, 10.8% of patients (n = 540) presenting with FTS of 1 had a mortality rate that increased to 6.1% (33 of 540). In contrast, combat casualties presenting with FTS of 0 had a significantly higher mortality of 41.4% (34 of 82) ($P < .01$; Fig. 1). The calculated lengths of stay were 6.1 ± 7.1 (FTS 2), 9.2 ± 11.3 (FTS 1), and 17.7 ± 21.8 (FTS 0) days (Fig. 2), with a significant difference between all groups ($P < .05$).

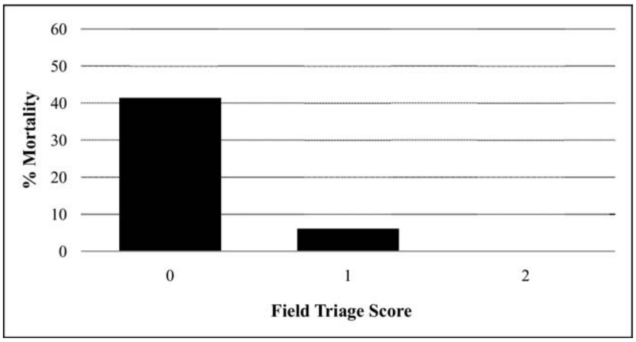

Figure 1 Mortality associated with the combat FTS score. $P <$ .05, all scores.

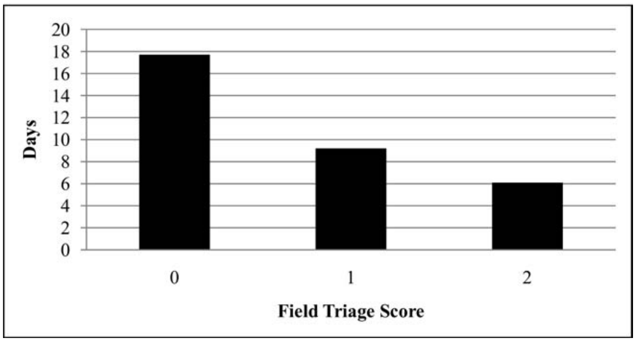

Figure 2 Length of stay associated with the combat FTS. $P < .01$, all scores.

Comments

In the present military conflict, there is an overall mortality rate of 8.8% of those wounded. Most of these deaths (78%) are killed in action, dying on the battlefield before medical intervention at a military medical treatment facility. However, there is a subpopulation (22%) of patients who die of wounds after admission to hospital facilities. Of those casualties who are killed, 82% have massive injuries that are inherently not survivable. However, there is a group (18%) that has potentially survivable injuries and may benefit from more expeditious evacuation and intervention.[24,25] The focus of combat casualty care research is identifying those potentially survivable individuals that if given appropriate triage and care would potentially survive.

In general, for a triage scoring system to be useful, it must meet several basic criteria, the most vital of which is its ability to correlate with meaningful outcomes. Commonly used outcomes in the trauma literature include ventilator days, ICU days, total hospital days, and mortality. Historical and contemporary literature establishes that the revised trauma score (RTS) is a valid predictor of mortality after trauma.[6,7] The value of the newly developed FTS not only has equivalent predictive power for mortality compared with the RTS but also its ability to predict nonmortality outcomes.[26] Another key asset of a functional scoring tool is "user friendliness," in that it must be practical and relatively simply applied. Common uniform disadvantages of many of the scoring systems include analytic complexity, thus limiting field utility. Another relative disadvantage of many of these triage scores is their reliance on physiologic monitoring resources. The FTS eliminates many of these shortfalls of other scoring systems, the advantage being that FTS requires no equipment and only rudimentary physical examination skills to develop the score.

This study is retrospective and thus has several limitations, including the inherent limitations of large registries such as the Joint Theater Trauma Registry. In addition, our current analysis was performed at admission instead of in the prehospital environment, using a measured SBP < 100 mm Hg as a surrogate for abnormal radial pulse character. The reason for this surrogate analysis is that the field capture of point of wounding data is extremely low because of resources, communications, multitier evacuation,and operational constraints imposed by the hostile combat environment.

Despite these limitations, the proposed FTS provides a simple and effective tool for classification of patients into categories to stratify evacuation and acute management, particularly in cases of multiple simultaneous patients.

Conclusions

Our study validates the FTS as a valid and efficacious trauma triage scoring system with the potential for profound implications in the prehospital triage of the combat casualty. The application of the FTS in the combat environment could provide a simple and effective tool for classification of patients into categories for patient management in circumstances in which treatment prioritization requires the stratification of multiple simultaneous patients. In addition, this technique may have implications for domestic or foreign disaster or mass casualty situations in which supplies, medical resources, and facilities are limited. Prospective validation of this technique in the prehospital environment is warranted.

References

1. Baxt WG, Berry CC, Epperson MD, Scalzitti V. The failure of prehospital trauma prediction rules to classify trauma patients accurately. Ann Emerg Med 1989;18:1–8.
2. Baxt WG, Jones G, Fortlage D. The trauma triage rule: a new, resource-based approach to the prehospital identification of major trauma victims. Ann Emerg Med 1990;19:1401–6.
3. Champion HR, Sacco WJ, Copes WS, Gann DS, Gennarelli TA, Flanagan ME. A revision of the trauma score. J Trauma 1989;29:623–9.
4. Champion HR, Sacco WJ, Hunt TK. Trauma severity scoring to predict mortality. World J Surg 1983;7:4–11.
5. Emerman CL, Shade B, Kubincanek J. A comparison of EMT judgment and prehospital trauma triage instruments. J Trauma 1991;31:1369–75.
6. Emerman CL, Shade B, Kubincanek J. Comparative performance of the Baxt Trauma Triage Rule. Am J Emerg Med 1992; 10:294–297.
7. Fries GR, McCalla G, Levitt MA, Cordova R. A prospective comparison of paramedic judgment and the trauma triage rule in the prehospital setting. Ann Emerg Med 1994;24:885–889.
8. Hedges JR, Feero S, Moore B, Haver DW, Shultz B. Comparison of prehospital trauma triage instruments in a semirural population. J Emerg Med 1987;5:197–208.
9. Knudson P, Frecceri CA, DeLateur SA. Improving the field triage of major trauma victims. J Trauma 1988;28:602–6.
10. Morris JA Jr, Auerbach PS, Marshall GA, Bluth RF, Johnson LG, Trunkey DD. The trauma score as a triage tool in the prehospital setting. JAMA 1986;256:1319–25.
11. Phillips JA, Buchman TG. Optimizing prehospital triage criteria for trauma team alerts. J Trauma 1993;34:127–32.
12. Rhodes M, Perline R, Aronson J, Rappe A. Field triage for on-scene helicopter transport. J Trauma 1986;26:963–9.
13. West JG, Murdock MA, Baldwin LC, Whalen E. A method for evaluating field triage criteria. J Trauma 1986;26:655–9.
14. Benson M, Koenig KL, Schultz CH. Disaster triage: START, then SAVE—a new method of dynamic triage for victims of a catastrophic earthquake. Prehosp Disaster Med 1996;11:117–24.

15. Garner A, Lee A, Harrison K, Schultz CH. Comparative analysis of multiple-casualty incident triage algorithms. Ann Emerg Med 2001; 38:541–8.
16. Nocera A, Garner A. An Australian mass casualty incident triage system for the future based upon triage mistakes of the past: the Homebush Triage Standard. Aust N Z J Surg 1999;69:603–8.
17. PHTLS basic and advanced prehospital trauma life support revised reprint. 5th ed. St Louis, MO: Mosby; 2005:464.
18. Butler FK Jr, Hagmann J, Butler EG. Tactical combat casualty care in special operations. Mil Med 1996;161(suppl):3–16.
19. Ekblad GS. Training medics for the combat environment of tomorrow. Mil Med 1990;155:232–4.
20. Holcomb JB, Salinas J, McManus JM, Miller C, Cooke W, Convertino V. Manual vital signs reliably predict need for life-saving interventions in trauma patients. J Trauma 2005;59:821–9.
21. Meredith W, Rutledge R, Hansen AR, et al. Field triage of trauma patients based upon the ability to follow commands: a study in 29,573 injured patients. J Trauma 1995;38:129–35.
22. Ross SE, Leipold C, Terregino C, O'Malley KF. Efficacy of the motor component of the Glasgow Coma Scale in trauma triage. J Trauma 1998;45:42–4.
23. McManus J, Yershov AL, Ludwig D, et al. Radial pulse character relationships to systolic blood pressure and trauma outcomes. Prehosp Emerg Care 2005;9:423–8.
24. Kelly JF, Ritenour AE, McLaughlin DF, et al. Injury severity and causes of death from Operation Iraqi Freedom and Operation Enduring Freedom: 2003-2004 versus 2006. J Trauma 2008;64(suppl):S21–7.
25. Holcomb JB, Stansbury LG, Champion HR, Wade C, Bellamy RF. Understanding combat casualty care statistics. J Trauma 2006;60:397–401.
26. Eastridge B, Salinas J, McManus J, et al. Field triage score (FTS): development and validation of a simple and practical pre-hospital triage instrument. J Trauma. In press.

Discussion

David Plurad, M.D. (Los Angeles, CA): I'd like to thank the Program Committee for the floor. Further, I would like to take this opportunity to thank Dr. Eastridge and his coauthors from the US Army for their continued work. I have four questions for the authors: First, please comment on the sensitivity of the FTS, particularly the use of blood pressure as a surrogate marker for pulse character. Second, how many casualties in the JTTR had complete requisite data adequate for analysis? Third, what is the quality and where do the data arise from with respect to the prehospital environment? And lastly, has this been prospectively evaluated, and if not, do you plan to do so?

Brian Eastridge, M.D. (Fort Sam Houston, TX): I would like to thank Dr. Plurad for his insightful commentary. With respect to the analysis and the FTS score, there clearly is a lack of sensitivity like all other scoring systems particularly when you are using fairly rudimentary variables in your analysis. Getting on to the questions, the first question was how many of the casualties in the Joint Theater Trauma Registry had complete requisite data for this analysis. It was about one third. The missing element that was most common was actually the GCS motor stratification of the GCS score. We had often the complete GCS score, but didn't have the GCS motor; it was one of the limitations. With respect to the second question on where did the data arise from, one of the limitations of the Joint Theater Trauma Registry is really one of the liabilities of the battlefield. With our corpsmen or medics in the field, unlike the EMTs in most of our civilian settings, they are constantly in a dangerous environment, they are being shot at, they have to maintain an offensive posture, meaning shoot back, and at the same time try and take care of casualties, so we don't have a lot of what we call Level I or prehospital data. Currently we estimate that approximately 5% of our casualties have decent pre-hospital data. There has been a big push by the US military to actually improve that by making use of technology. Once the medics get back to their forward operating base we encourage the medics to enter that data in later. Most of the data for this analysis came from Level II and Level III facilities. Level II facilities for those of you that are not familiar are basically the forward surgical facilities, generally 10–20 person surgical contingents and Level III are the big combat support hospital or combat support hospital equivalents. Question 3 – Clearly we need to prospectively validate this measure. We would like to prospectively validate this on the battlefield. And the last question with respect to how do we convince our medics and corpsmen that this is the right thing to do. Anybody who has ever been out there and there are probably many out here that have been deployed, it is very difficult to give up on a wounded casualty despite the gravity of their condition, so really this triage score is not meant to be fielded to justify giving up on their wounded friend, but really gives them some idea that the casualty with an FTS score particularly of 0 so the abnormal pulse character and the abnormal GCS motor, those folks require generally higher acuity, probably need to be more vigorously and expeditiously evacuated.

Ernest Moore, M.D. (Denver, CO): I have never been in the stressful scenario you describe, but I am curious how you arrived at the threshold $<$100 mmHg. As you know, most of us believe the ATLS propaganda that the radial pulse represents 80 mm Hg and carotid is 60 mmHg. Consequently, most of us in the Trauma Room in the middle of the night when we can't hear the nurses and feel for a radial, then femoral, and then we feel for a carotid as we do a resuscitative thoracotomy, and this approach seems to be a pretty reliable. I am just curious why the 100 and did you look at the potential use of the carotid and femoral as well.

Dr. Brian Eastridge: That is a great question. We were striving for absolute simplicity in our model. We did not use the carotid and femoral because our thought process was that then the sensitivity may lead to a great deal of undertriage. The level that we use of a 100 is probably 90-100 and was validated in a study done by McManus in 2003 where he actually looked at casualties with the radial pulse characteristic and when the clinician would say that this is clearly diminished pulse character and it was right around 100 mmHg. Although subjective, he demonstrated a strong interrater reliability in this analysis.