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ORIGINAL ARTICLE

A NEW FIELD TRIAGE METHOD FOR BURN DISASTERS - FTB (FAST TRIAGE IN BURNS)

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Summary

The FTB (Fast Triage in Burns) algorithm is a new triage method dedicated to massive burn events in the field and in civilian circumstances. FTB relies on the evaluation of: the extent of deep burns, estimated systolic pressure (by verifying the presence of a pulse on the three key arteries – the carotid, femoral, and radial artery), the total extent of the burn, and presence of concomitant inhalation trauma. The FTB algorithm is a simple, quick, and credible means of segregating burn victims. The algorithm is dedicated to use in pre-hospital care, during mass-casualty events both in civilian and battlefield circumstances. The aim is to be able to evaluate burn victims immediately, without access to medical equipment or additional tests. As a result, the rescuers have an ability to quickly divide the patients into four categories of medical assistance and evacuation urgency. The FTB algorithm concept and principles for battlefield use assumes that patients with less severe burns are the first in line to receive medical assistance, as they are more likely to return to duty.

Key words: burns; triage; field care; FTB

INTRODUCTION

Burns in the battlefield occur in 5% to 20% of all military injuries [1,2]. 20% of burned soldiers are diagnosed with severe burns, over 20% TBSA [3,4]. Face, with inhalation injury, and hands are most often burned, because they are not protected with the military uniform [1]. Burned soldiers are usually between the age of 20 and 55 years old, but when the incident deals with civilians, all age groups can be affected. Military burns over 50% of TBSA are classified as mortal, especially when there is limited access to specialist burn units [1]. Rescuers in the battlefield dealing with severe situations and burn catastrophes, when not all injured can be reached, use segregation systems, from French 'triage', to optimize actions and use medical supplies most effectively.

The most crucial factors predicting lethality in burns are: extent of burn in percent of total body surface area (TBSA) and age. There are several prognostic scales that are built on these two factors. Other methods include inhalation burns, extent of deep burns, the patient's gender, and location of burns. Modern prognostic scales rely on methods used in intensive care - the APACHE II score and the SOFA score. Prognostic tools used in hospital

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practice, however, might not be optimal for critical situations, when the number of the victims surpasses the number of the rescuers. The authors believe that in mass accidents, especially in the battlefield, when the victims are most often young, age is of lower importance in predicting death.

METHODS

A retrospective analysis of 939 burned patients admitted to the Clinical Department of Burns, Plastic and Reconstructive Surgery, Military Institute of Medicine (MIM) in Warsaw and to the Centre for the Treatment of Burns (CTB) in Siemianowice Slaskie in 2012 and 2013 was performed. From the population of all burned patients, a group of 842 patients with thermal burns (flame, steam, boiling water) was selected.

Early factors that could be used during segregation of burn victims in mass incidents in the battlefield and in civilian circumstances were revealed by statistical analysis. Only easy and quick-to-evaluate factors, ones that can be examined without medical equipment and laboratory tests, were used in creating the proprietary triage algorithm [Table 1]. The selected factors were statistically evaluated in order to verify which had the greatest impact on early death, from 0 to 4 days from the occurrence of the burn. Moreover, the factors that strongly impacted death despite adequate specialist treatment in a burn unit were evaluated as well.

Table 1. Vital signs in the burn victims group evaluated on admission to the facility.

Variables	N	Average	Median	Minimum	Maximum	Percentile 25	Percentile 75	St. dev.
HR	820	85,70	84,00	26,00	145,00	78,00	90,00	15,34
Body temperature	707	36,50	36,60	26,60	39,00	36,60	36,60	0,57
Breaths per minute	681	14,88	16,00	8,00	24,00	13,00	16,00	2,32
GCS	834	14,07	15,00	8,00	18,00	15,00	15,00	2,37
Systolic pressure	813	130,83	130,00	0,00	210,00	120,00	142,00	25,44
Diastolic pressure	812	80,01	80,00	0,00	130,00	70,00	90,00	15,04

RESULTS

Results of a multi-layered statistical analysis outputted parameters that strongly predicted death in burn victims and can be evaluated without access to medical equipment, therefore they allow performing credible evaluation even in the most adverse conditions. Factors that strongly predict early death, i.e. death in the first four days from the occurrence of the burn, were also adopted for triage purposes [Table 2]. The parameters yielded by the analysis included the extent of deep burns ($p<0.00001$, OR=1.06), systolic pressure ($p<0.00001$, OR=0.95), and presence of inhalation trauma ($p=0.0019$, OR=31). The second element used in the algorithm's design comprised parameters that strongly predict death despite administration of multi-disciplinary treatment. Extent of deep burns ($p<0.00001$, OR=1), TBSA ($p<0.00001$, OR=1.01), and presence of inhalation trauma ($p=0.0002$, OR=6.05) were included in the analysis. The following were the limit values for the risk of death:

- Black – risk of death over 95% - patients without a chance of survival, 'expectant' , solely symptomatic treatment.
- Red – risk of death between 5 and 50% - patients who require quick, priority medical intervention/ and or evaluation. Patients with higher chances to return to duty.
- Yellow – risk of death between 50 and 95% - patients who are second in line for medical intervention, although failure to administer early treatment (e.g. intubation, fluid therapy) involves significant risk of the patient's status changing to black. In mass casualties, this is a secondary group of medical intervention due to high lethality risk.
- Green – risk of death below 5% - patients who don't require medical intervention, outpatients, able to perform body aid. [Figure 1].

Table 2. Summary of multiple regression for vital signs and burn data with statistically significant impact on death in the single-factor analysis (marked in red).

N=764	b*	St. error	B	St. error	t(756)	p
Offset			-0.117341	0.073490	-1.59669	0.110752
Age	0.223584	0.024668	0.004680	0.000516	9.06355	0.000000
%TBSA	0.258839	0.043183	0.004422	0.000738	5.99406	0.000000
Respiratory tract	0.092895	0.026419	0.067940	0.019322	3.51618	0.000464
%III	0.395509	0.041114	0.008500	0.000884	9.61971	0.000000
HR	0.027248	0.025598	0.000651	0.000611	1.06446	0.287459
Systolic pressure	-0.113280	0.036602	-0.001614	0.000521	-3/09495	0.002041
Diastolic pressure	-0.001242	0.036126	-0.000030	0.000863	-0.03437	0.972592

>95% EXPECTANT SYMPTOMATIC TREATMENT	50 95% MEDICAL INTERVENTION AND SECONDARY PRIORITY EVACUATION REQUIRED	50 5% URGENT MEDICAL INTERVENTION AND PRIORITY EVACUATION REQUIRED	<5% MINIMAL

Figure 1. Guidelines for the triage method.

The analysis indicates that the extent of deep burns is the parameter that needs to be evaluated first. If over 50% of the patient's body is affected by a deep burn, there is no chance of survival and the patient has to be marked as *black*. If the patient is diagnosed with less than 5% of deep burns, then the risk of death is also below 5%. Such patients can wait for medical help, and are able to self-medicate or assist others. Patients estimated to have below 50% and above 5% TBSA affected by deep burns require further triage. At the second stage of segregation, FTB suggests evaluating systolic pressure, therefore presence (or lack thereof) of signs of shock. Overview evaluation of systolic pressure can be performed by means of pulse palpation at three sites: the radial, femoral, and carotid arteries. Presence of a pulse on the radial artery indicates that systolic pressure is above 80 mmHg, on the femoral artery – over 70 mmHg, and on the carotid artery – over 60 mmHg. Lack of a pulse at the sites listed above indicates that the patient's systolic pressure is below 60 mmHg, despite symptomatic treatment. This signifies centralised blood circulation, insufficient perfusion of the key organs, and a risk of death above 95%. Such patients need to be treated symptomatically. If the patient's systolic pressure is estimated to be above 60 mmHg, their entire body surface area affected by the burn needs to be evaluated [Figure 2].

DISCUSSION

The purpose of triage in mass casualty events is to provide the greatest benefit to the greatest number of casualties (Jeremy Bentham). Triage pursuant to NATO guidelines, or the so-called DIME standard, distinguishes five groups of casualties [5]. During the intervention, paramedics mark the victims classifying them with the relevant categories. In most cases, the white colour is used to marked fatalities. Black or blue are attributed to casualties with no chance of survival, therefore ones that receive only symptomatic treatment. The red colour is attributed to urgent cases who will die if they do not receive immediate medical help. Such victims need to be the first ones in line for treatment. The yellow colour is used to mark patients who do not require medical intervention despite being diagnosed with severe injuries, and their condition is stable enough for them to receive medical assistance

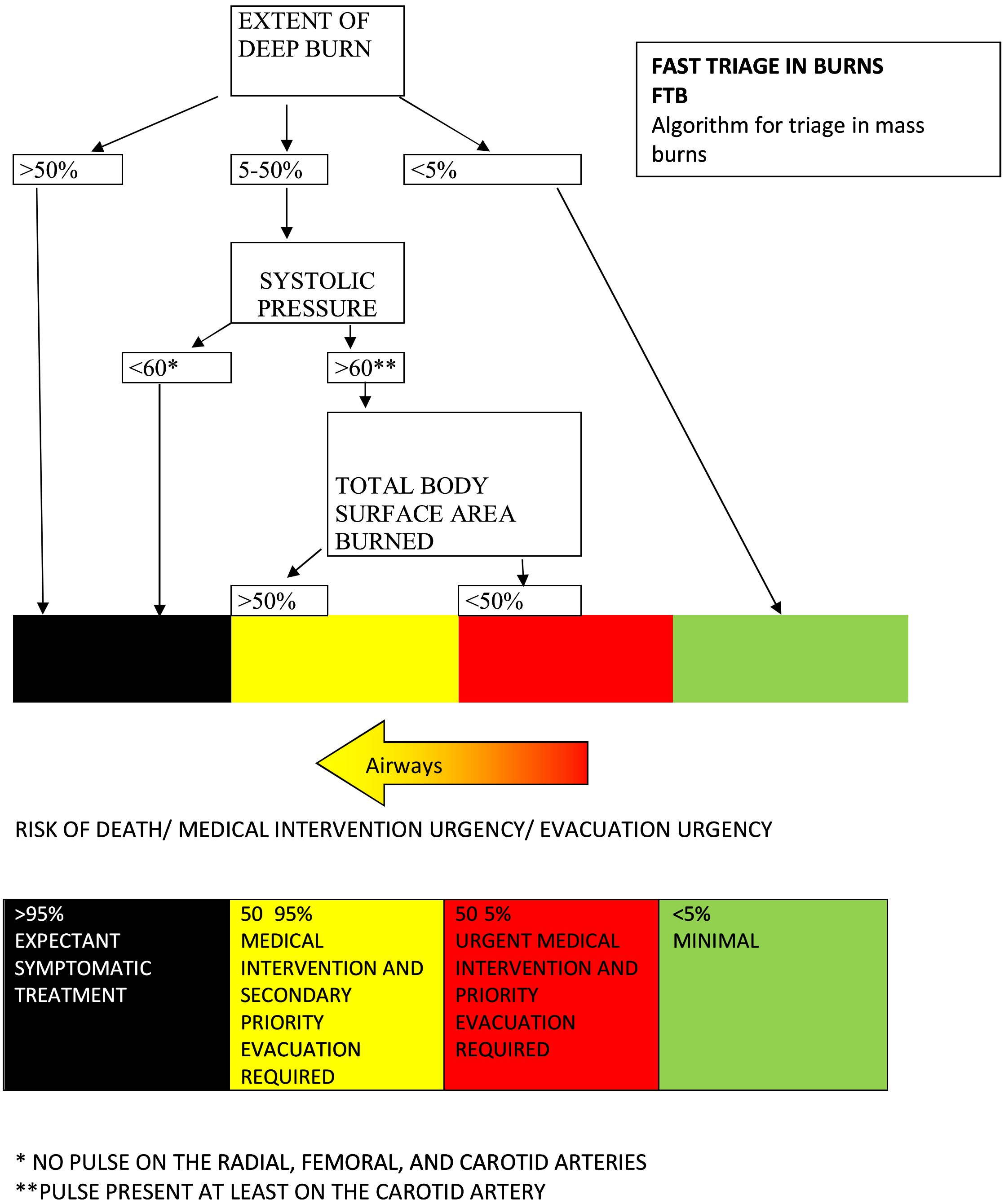

Figure 2. FTB (Fast Triage in Burns) - a concept for military purposes.

next in order. Green badges are used only for victims who do not require medical help on site. Their injuries are not life threatening, and they can be treated as outpatients. Such patients are able to self-medicate and to assist each other. The methods and algorithms that list the criteria for allocating victims to the individual categories are numerous. Such algorithms differ for non-war-related and war-related mass-casualty events. In circumstances of armed conflict, evacuation of casualties from ground zero may take several days, with limited access to medical supplies. The casualties are primarily young persons, therefore the author believes that prognostic methods that rely on patient age may be of lower significance in such cases.

The FTB algorithm is a simple, quick, and credible means of segregating burn victims. The algorithm is dedicated to use in pre-hospital care, during mass-casualty events both in civilian and battlefield circumstances. The intention is to be able to evaluate burn victims immediately, without access to medical equipment or additional tests. The result is the ability to quickly divide the patients between four categories of medical assistance and evacuation urgency. The following are the fundamental patient evaluation tools of the FTB: the extent of deep burns, systolic pressure, total extent of the burn, and presence of inhalation trauma. In military circumstances, FTB gives priority to victims with higher chances for quick recovery.

Burn victims with over 50% TBSA burned are characterised with higher lethality risk. On the other hand, patients with less than 50% TBSA burned in the battlefield should be the first to deliver medical help. If patients from this "red" sub-group are affected by inhalation trauma, they need to be moved to the "yellow group". Suspected inhalation trauma involves clinical signs and signs such as charring in the nasal and oral cavities, swelling of the oral cavity, hoarseness, respiratory failure signs, and burns sustained in closed spaces.

It needs to be kept in mind that the condition of burn victims can change rapidly. Patients with normal circulation (systolic pressure over 60 mmHg) can become patients with a prognosis of death in a matter of minutes. The authors suggest that, as far as possible, patients should be evaluated more than once (with the exception of patients allocated to the "black" group). Furthermore, assessment of the extent of the burn is only an estimate. In order to avoid mis-categorisation of patients as a result of erroneous estimation of the extent of their burns (up to 5%), very high values of risk of death have been adopted as the cut-off points for the algorithm. Risk of death over 90% and below 10% could be considered valid for segregation. However, it is the author's opinion that the risk of mis-categorisation of burn victims needs to be minimised, especially with regard to the black and green groups, hence such high criteria were adopted.

The concept of the algorithm intended for use in mass-casualty events in the battlefield differs from the triage concept for civilian purposes. This is connected with the different organisation systems, medical assistance levels, and different allocation of manpower and resources. The most important difference is in the urgency categories for the red and yellow groups. In the military version of the FTB algorithm, victims who are not only likely to survive, but also able to return to duty quickly should be given priority medical help. Acting according to the RTD (*Return to duty*) rule is closer to the system applied by Napoleonic-era triage pioneers than to civilian triage methods. In the military review of the algorithm, patients from the group with 5-50% of deep burns, palpable pulse (with no signs of shock), and below 50% TBSA burned receive priority medical treatment and evacuation. There are reports in literature of 40-45% TBSA burns being considered borderline fatal in the battlefield [1]. Patients with more extensive burns need to be categorised as "expectant". This is in line with the guidelines published by the Polish Army's Military Healthcare Consultant on plastic surgery [13].

CONCLUSIONS

In the case of battlefield triage, the priority is to save casualties that may be able to return to duty. For that reason, the military variant of the FTB prioritises casualties from the less severely burned and "green" groups, therefore the least severely injured patients, whereas severely burned casualties and patients with concomitant inhalation trauma are granted secondary priority. FTB (Fast Triage in Burns) algorithm is a reliable method to perform triage in burn catastrophes in the field.

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