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The survival probability function as an augmenting element of the automated triage system on the battlefield

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Abstract

Mass events are incidents involving a large number of casualties. They are an integral part of combat operations. These events are characterized by exceeding the capabilities of the rescuers present at the scene during a specific phase of the operation. The difference in triage applied in combat compared to triage used in civilian mass events is directly related to their specific nature and intended objectives. The article presents an innovative segregation algorithm that takes into account the value of the so-called "survival function," which is a component of a medical evacuation decision support system based on the integration of monitoring and analysis of soldier's vital parameters with the medical security system.

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Keywords: triage, survival function, segregation algorithm, medical evacuation, MASCAL

1 Introduction

During armed conflicts, the priority is to achieve the set tasks and objectives. Resources are always limited throughout their duration. The evacuation of casualties may involve multiple stages and be prolonged in time. Medics face extended care on the battlefield, tending to the injured for much longer than in civilian Mass Casualty (MASCAL) incidents with limited access to medical equipment, which is typically used in civilian incidents. The utilization of the latest available methods for collecting and processing medical data to optimize triage undoubtedly enables the optimization of rescuer procedures in the theater of operations. Determining the condition of the victim already at the stage of reaching him, allows gaining time, which is a key role in the survival of the victims. The article characterizes the most crucial human vital parameters from the perspective of triage and presents a proposed decision tree-based classification algorithm for use in the Polish Armed Forces, along with the definition and properties of the

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so-called survival probability function. The proposed algorithm takes into account the possibility of missing one or more signals carrying information about vital parameters. The presented algorithm is part of a developing medical evacuation decision support system that integrates monitoring of soldier's vital parameters with the medical support system. The measurement component, which includes a personal analyzer for selected vital parameters of the soldier, is tasked with providing a set of key diagnostic parameters. The analysis and inference component, the subject of this article, will recommend the operator of the system to assess the soldier's well-being based on the collected parameters and propose support in the medical evacuation decision-making process.

2 Vital parameters

2.1 Pulse

Pulse is the rhythmic expansion and contraction of arterial walls caused by blood being ejected during the heart's contraction. The basic characteristics describing the pulse include frequency, determined by the number of beats felt per minute, and regularity – a pulse is regular if all beats exhibit consistent force, and the intervals between them are uniform; otherwise, it is referred to as an irregular pulse. The pulse can be accelerated (tachycardia) or slowed down (bradycardia), which depends on various factors. Acceleration occurs during physical exertion, stress, shock, substance use, emotional reactions, high fever, bleeding, and heart diseases. Pulse slows down in cases such as sleep, rest, after meals, in athletes, divers, after using certain medications, in some heart conditions, and head injuries (Owczuk, 2021).

2.2 Respiration

The process of breathing serves to supply the body with oxygen and remove carbon dioxide. It has two phases: inhalation, during which air is drawn into the lungs due to the contraction of muscles, and exhalation, which involves the passive reduction of chest volume. Normal breathing is regular, effortless, without pathological noises, uniformly deep, odorless, and the chest rises and falls symmetrically. When evaluating a patient's breathing, attention should be paid to: respiratory rate, depth of breaths, breath sounds, and respiratory rhythm (Szczeklik, Gajewski, 2014).

2.3 Blood presure

Blood pressure refers to the force exerted by blood on the walls of arteries, with the term typically denoting pressure in the largest arteries, such as the arm artery. Blood pressure undergoes constant changes in the long term (related to age, health status, etc.), medium term (depending on the time of day, activity, mental state, substance use, etc.), and short term (within the cardiac cycle). During the heart's contraction, when a portion of blood is ejected from the heart into the aorta, the highest pressure prevails in the arteries, typically ranging from about 90 to 135 mm Hg in healthy adults; during diastole, it is the lowest, ranging from about 50 to 90 mm Hg.

In medical practice, both systolic and diastolic blood pressure values are important for assessing a person's health, so both values are provided, written as, for example, 120/80 mm Hg. The pulse pressure, the difference between systolic and diastolic blood pressure, is typically 30-50 mmHg under physiological conditions (Williams et al. 2018).

2.4 Body temperature

Human body temperature largely depends on the measurement location, time of day, and the patient's activity level. Contrary to popular belief, there is no single, constant body temperature for all individuals. The proper functioning of the body relies on maintaining the internal environment's temperature through thermoregulatory mechanisms. The normal body temperature of a healthy person (measured under the armpit) ranges from 36.0 to 37.2 °C.

The thermoregulation center is located in the central nervous system. Excess heat is dissipated through the skin (sweating), the respiratory system, and the digestive tract. Heat deficit in the body manifests as vasoconstriction, reduced sweating, shivering, and muscle tremors.

2.5 Oxygen saturation

The most common method for measuring arterial oxygen saturation (arterial blood oxygen saturation) in medical settings is pulse oximetry. Monitoring a patient's condition during general anesthesia for medical procedures, during oxygen therapy, and in the case of severe illness is particularly important. Saturation is defined as the percentage of oxygen-bound hemoglobin (oxyhemoglobin) relative to the total amount of hemoglobin. Saturation values typically fall within the range of 94 to 98% or higher (smokers may have slightly lower values). Saturation below 90% indicates hypoxia, which can be caused, among other things, by anemia. A low $SpO2$ is characterized by cyanosis.

2.6 End-tidal carbon dioxide

End-tidal carbon dioxide ($EtCO2$) measurement finds numerous applications in pre-hospital and in-hospital conditions. Intubating a trauma patient or one experiencing anaphylactic shock in the context of a medical rescue team or an emergency department differs significantly from intubating a patient prepared for elective surgery in an operating room (fasting patient, optimal intubation conditions - appropriate lighting and table height, preoxygenation, the ability to summon a more experienced anesthesiologist in case of anticipated difficult intubation, as well as a wide range of alternative methods for maintaining airway patency). $EtCO2$ is one of the key indicators for assessing high-quality circulatory and respiratory resuscitation.

Various devices are available on the market to measure the end-tidal carbon dioxide level in exhaled air. They differ not only in price but mainly in measurement method, and thus accuracy and applicability in various cases.

3 Triage systems

Medical triage systems, or triage systems, were introduced into emergency response procedures in response to incidents involving a large number of casualties. Their primary objective is to save as many injured individuals as possible. Various triage schemes are employed in emergency services, yet none are truly universal. The earliest references to triage systems can be traced back to the Napoleonic Wars. Ironically, they did not emerge with the intention of saving human lives but rather for the more practical purpose of restoring injured soldiers' combat capabilities. The needs of the Napoleonic military leadership coincided with the efforts of two surgeons, Pierre-François Percy (1754-1825) and Dominique Jean Larrey (1766-1842), who already possessed experience and achievements in treating wounded soldiers. Specialized literature does not definitively attribute the creation of the first triage system to any one individual. However, Larrey's concept had a profound impact on reducing the number of deaths on the battlefield. Based on his concept, casualties were evacuated from the theater of operations and sent to field hospitals based on assessment in three categories:

- Life-threatening injuries,
- Injuries less hazardous to life,
- Minor injuries.

The word "triage" originates from the French language (triage - sorting) and has been adopted as the term for medical sorting in disaster and mass casualty medicine.

Medical triage maximizes the chances of responders on-site providing essential aid to the greatest number of casualties in the shortest possible time. The use of triage allows for a rapid assessment of casualties at the incident scene and the establishment of evacuation priorities. There are numerous medical sorting systems worldwide. Differences stem from local medical protocols, the nature of the incident, the quantity of forces and resources involved in the operation, and the distance from the incident scene. The abundance of these systems arises from their imperfections, which drive their continuous development. None of the currently used systems is sufficiently universal to be suitable for all locations or incidents. Hence, there is a need for both the development of sorting systems themselves and the tools that support medical personnel during triage.

Several of the most popular triage systems, directly or indirectly, are applied in both civilian and military Polish conditions, as presented in article (Dobrowolski et al. 2018). These systems include START (Simple Triage and Rapid Treatment), SALT (Sort, Assess, Lifesaving Interventions, Treatment/Transport), CAREFLIGHT, SIEVE, and NATO Triage.

In the context of the battlefield, where every pair of hands in the fight against the enemy is invaluable and resources are limited, the concept of medical sorting is entirely different from that used in civilian conditions. In such circumstances, reverse triage is employed (Pollaris, Sabbe, 2016). The priority is to provide assistance to those who can quickly regain combat capability. Only such an approach can offer a chance of survival to the remaining members of the unit. An example could be a soldier with a hand injury and another with a massive chest injury. In a standard approach, priority would be given to the more severely injured individual, but in the battlefield, it may be more advantageous for both casualties to provide first aid to the soldier with the hand injury. A similar situation can also be imagined in critical incidents in the civilian environment.

Reverse triage also refers to the shifting of patients in hospital wards who can survive the next 96 hours. More critically injured patients, whose lives are in jeopardy, are admitted in their place. This situation can occur when a large number of casualties are admitted to a hospital unit simultaneously. Since no hospital can accommodate an excessively large number of casualties, this method may be the only solution.

MASCAL events, both in civilian and wartime settings, pose one of the greatest challenges for medical professionals. In adverse conditions, this challenge becomes even more difficult. Naturally, the emergence of a chaotic phase resulting from the multitude of life-threatening conditions and the threat to safety at the incident scene makes it extremely difficult to create a system fully prepared for every eventuality. The primary goal of new triage systems is to minimize the risk of errors. To achieve this, various innovations and improvements are implemented. The use of computer techniques, artificial intelligence, applications, and management systems can assist triage personnel in making quick and accurate decisions.

Primary triage is intended to be fast; the system for re-triage, which allows the determination of the order of interventions among the most severely injured and the order of evacuation, will be much more complex and comprehensive. The implementation of new technological solutions, which minimize the potential for human error, as well as the collection and real-time analysis of medical data, will enable rapid identification of the condition of casualties and the establishment of treatment priorities, especially in the theater of operations. In today's world, when warfare has taken on an entirely new form, solutions that offer a chance of survival to the wounded must be sought. The use of artificial intelligence can optimize the actions of responders from the moment they arrive at the incident scene.

4 Automatic triage algorithms in the battlefield

The component of analysis and inference in the system developed by the WAT-WIM-PIB-TELDAT consortium (Łubkowski et al., 2023) is tasked with performing automatic triage, which is intended to facilitate the medical services in sorting injured individuals in mass casualty incidents based on the extent of their injuries and prognosis. Through extensive analysis and environmental consultations, it was determined that the segregation of casualties would be associated with assigning them to four groups, denoted by colors:

- **Green -** healthy (this category also includes lightly injured soldiers with essential life parameters within normal range - such soldiers have a 100% chance of survival),
- **Yellow -** for evacuation in the second priority,
- **Red -** for immediate evacuation (first priority),
- **Black -** not salvageable under limited resources and means - a terminal case with no chance of survival.

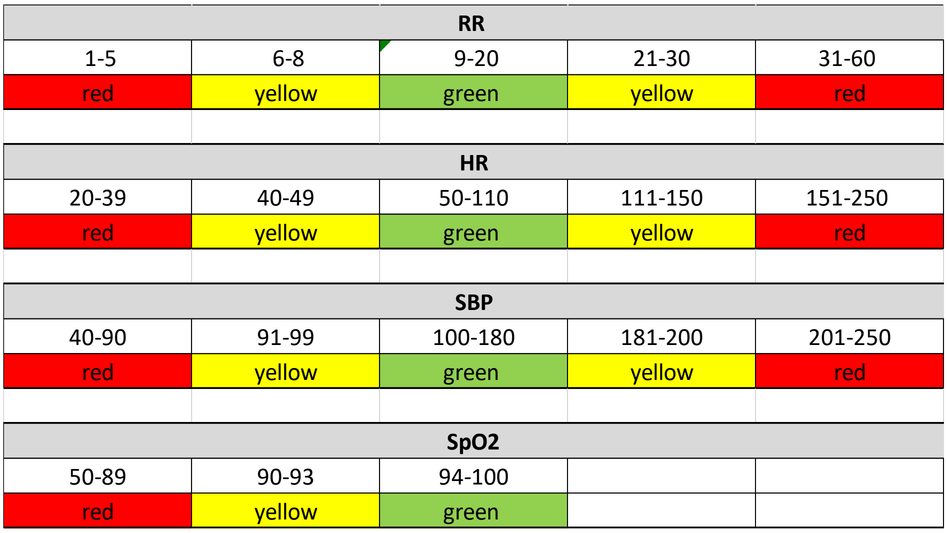
The black color can only be assigned by a rescuer (the algorithm automatically assigns only green, yellow, or red, optionally blue, which indicates that the system does not receive an HR signal).

During the research work, a variety of decision algorithms were thoroughly analyzed and compared, each of which - even belonging to the group of most popular ones - had certain limitations. Ultimately, the authors opted for a decision tree, which is a very useful model as long as it does not become overly extensive. Decision trees are widely used in medicine and epidemiology (Mello, 2006; Zhang, 1996). Their advantages include ease of interpretation and visualization, as well as computational speed, while their disadvantage is the complex structure when the model is multi-parametric.

The medical team from the Military Institute of Medicine - State Research Institute in Warsaw has analyzed numerous potential diagnostic parameters and presented a rationale for selecting four fundamental parameters upon which triage will be based. These parameters are:

1. Respiratory Rate (RR) – estimated from the signal of a tensiometric sensor.
2. Heart Rate (HR) – estimated from EKG and PPG.
3. Systolic Blood Pressure (SBP) – estimated from EKG and PPG.
4. Peripheral Oxygen Saturation (SpO2) – estimated from PPG.

Additionally, body position and physical activity, determined using accelerometers, are taken into account. The analysis of triage systems and the vital parameters assessed within them has led to the decision to choose these vital parameters as the most critical, objective, and reliable for assessment in the context of battlefield conditions or incidents involving a large number of casualties.



RR				
1-5	6-8	9-20	21-30	31-60
red	yellow	green	yellow	red
HR				
20-39	40-49	50-110	111-150	151-250
red	yellow	green	yellow	red
SBP				
40-90	91-99	100-180	181-200	201-250
red	yellow	green	yellow	red
SpO2				
50-89	90-93	94-100		
red	yellow	green		

Table 1. *Parameter limits*

Simultaneously, the medical team has devised a triage algorithm that replicates various types of injuries, along with assigning corresponding categories in the convention of red (R), yellow (Y), and green (G). In this algorithm, the categories escalate sequentially: G → Y → R. The system possesses the capability to elevate the risk category upon the detection of anomalies in the measurement of a given parameter; however, it lacks the capacity to decrease this category if subsequent parameters are within the normal range. In other words, in successive decision branches, the algorithm may either maintain or potentially raise the risk category.

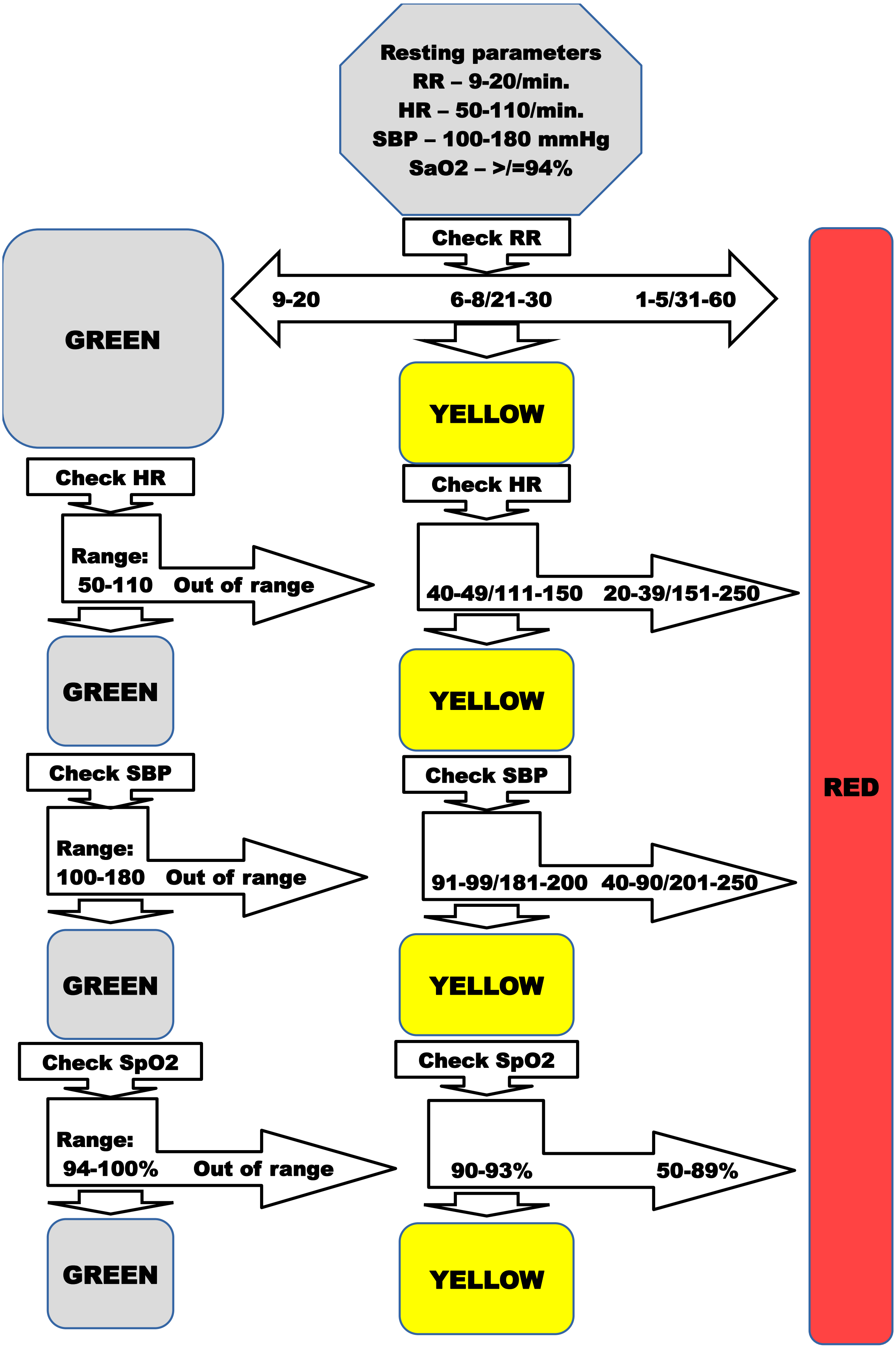


Figure 1. *Computer-aided triage algorithm*

The assignment of parameters to successive decision levels is as follows:

1 – 2 – 3 – 4

RR – HR – SBP – SpO2

The categorization is based on the expected reliability of measurements in field conditions rather than their importance, defined as follows:

- HR – highest priority, the system cannot function without this parameter;
- RR – a parameter that responds rapidly to changes in the patient's condition - compensation/decompensation; the absence of breathing can be caused, for instance, by the patient's position, and airways can be easily cleared to restore breathing;
- SBP – a parameter secondary to the above parameters, reacting with a "delay";
- SpO2 – a parameter with lower reliability, dependent on a multitude of factors.

The decision thresholds for the parameters are summarized in Table 1, and the resulting classification algorithm is depicted in Figure 1.

5 Survival probability function

The core algorithm presented in the previous chapter maps four parameters: RR, HR, SBP, and SpO2, to three colors: G, Y, R. This algorithm is applied when all four stable signals are available: HR, RR, SBP, and SpO2, and it only makes sense for a stationary soldier (for some time) – the information on activity (accelerometers and GPS) is used to detect this state.

Based on this algorithm, an auxiliary algorithm has been defined to determine the so-called survival probability function. The need for such a function arises from expectations related to the introduction of triage-supporting software. The evacuation order is determined by color, but within the same color, the value of the survival probability function can decide. In the case of tactical (reverse) triage, where the priority is to quickly restore combat readiness, meaning that the lightly injured should be rescued first, knowledge of the survival probability function values will also be very helpful. Generally, the more aggregated information the rescuer receives, the easier it is for them to make a decision.

The first version of the survival probability function was constructed based on non-linear SVM networks (Dobrowolski et al., 2015, 2016, 2021). To define the function, 7200 cases were generated, evenly covering the entire four-dimensional parameter space. These cases were used to train two non-linear SVM networks, resulting in the final Survival Probability Function, which assigns a range of 1 – 50% to the red class, 51% – 99% to the yellow class, and 100% to the green class. The variability of this function is presented in (Łubkowski et al., 2023). During further research, while analyzing the course of the survival probability function calculated for over 7,000 clinical cases, it was found that the non-linear survival probability function tends to underestimate survival chances at high systolic pressures. Therefore, following the recommendation of the medical team, a new linear survival probability function based on distance measures in an adaptively normalized feature space was developed, which, as before, assigns a range of 1 – 50% to the red class, 51% – 99% to the yellow class, and 100% to the green class. The values of the survival probability function for the selected group of cases from the red and yellow classes are presented in Table 2.

RR	**HR**	**SBP**	**SpO2**	**ICD-10 Diagnoses**	**Triaż**	**Szanse przeżycia**
15	97	255	97	Superficial Injury of Scalp	Red	**22%**
12	117	246	92	Fracture of Neck of Femur	Red	**27%**
12	87	236	95	Fracture of Orbital Floor	Red	**32%**
12	91	65	100	Contusion of Ankle Joint	Red	**37%**

12	110	225	99	Superficial Injury of Scalp	Red	**38%**
15	91	220	97	Superficial Injury of Head, Unspecified	Red	**40%**
14	74	219	94	Fracture of Proximal End of Humerus	Red	**41%**
40	107	126	99	Fracture of Other Toe(s)	Red	**42%**
16	81	214	97	Superficial Injury of Nose	Red	**43%**
10	55	161	80	Traumatic Subarachnoid Hemorrhage	Red	**44%**
12	98	143	80	Subtrochanteric Fracture	Red	**44%**
12	75	210	96	Unspecified Intracranial Injury	Red	**45%**
18	170	130	98	Traumatic Pneumothorax	Red	**45%**
18	170	130	98	Fracture of Coccyx	Red	**45%**
18	170	130	98	Fracture of Ilium	Red	**45%**
11	102	208	99	Rib Fracture	Red	**46%**
15	100	145	85	Fracture of Neck of Femur	Red	**47%**
18	99	207	98	Multiple Fractures of Lower Leg	Red	**47%**
12	52	204	98	Other Intracranial Injuries	Red	**48%**
14	137	169	86	Unspecified Injury of Shoulder and Upper Arm	Red	**48%**
17	79	135	87	Fracture of Coccyx	Red	**48%**
15	85	205	94	Fracture of Other Skull and Facial Bones	Red	**48%**
11	82	202	96	Superficial Injury of Scalp	Red	**49%**
16	91	88	94	Open Wound of Eyelid and Periocular Area	Red	**49%**
14	71	89	100	Open Wound of Lip and Oral Cavity	Red	**49%**
14	111	201	95	Injury to Multiple Structures of Knee	Red	**50%**
14	135	198	94	Open Wound of Scalp	Yellow	**73%**
14	100	160	90	Contusion of Eyelid and Periocular Area	Yellow	**75%**
16	80	200	96	Superficial Injury of Scalp	Yellow	**75%**
12	76	199	97	Dislocation of Ankle Joint	Yellow	**76%**
11	84	198	93	Contusion of Ankle Joint	Yellow	**77%**
16	87	95	91	Contusion of Hip	Yellow	**77%**
16	87	95	91	Fracture of Shaft of Femur	Yellow	**77%**
11	145	171	95	Multiple Fractures of Lower Leg	Yellow	**78%**
14	79	196	98	Fracture of Sternum	Yellow	**80%**

12	64	196	95	Open Wound of Other Parts of Forearm	Yellow	**80%**
12	70	109	91	Superficial Injury of Scalp	Yellow	**81%**
11	65	94	100	Injury of Eye and Orbit, Unspecified	Yellow	**83%**
12	80	94	99	Open Wound of Arm	Yellow	**83%**
14	135	133	98	Fracture of Neck of Femur	Yellow	**84%**
12	135	130	97	Diffuse Brain Injury	Yellow	**84%**
12	86	193	97	Multiple Rib Fractures	Yellow	**84%**
14	70	193	95	Superficial Injury of Scalp	Yellow	**84%**
14	70	193	95	Fracture of Tooth	Yellow	**84%**
14	69	97	92	Superficial Injury of Head, Unspecified	Yellow	**85%**
12	62	192	94	Rib Fracture	Yellow	**85%**
14	121	190	95	Injury to Multiple Structures of Knee	Yellow	**86%**
12	110	191	99	Unspecified Injury of Hip and Thigh	Yellow	**86%**
12	132	136	95	Injury of Eye and Orbit, Unspecified	Yellow	**86%**
12	87	95	99	Fracture of Mandible	Yellow	**86%**
12	89	182	92	Contusion of Hip	Yellow	**87%**
16	131	120	96	Fracture of Patella	Yellow	**87%**
11	79	177	92	Contusion of Hip	Yellow	**88%**
11	79	177	92	Fracture of Neck of Femur	Yellow	**88%**
12	61	96	98	Superficial Injury of Scalp	Yellow	**89%**
12	61	96	98	Open Wound of Eyelid and Periocular Area	Yellow	**89%**
20	125	105	94	Unspecified Head Injury	Yellow	**91%**
18	52	187	99	Fracture of Metatarsal Bones	Yellow	**91%**
16	125	139	99	Contusion of Shoulder and Upper Arm	Yellow	**91%**
14	69	97	96	Sprain and Strain of Shoulder Joint	Yellow	**92%**
17	81	97	99	Multiple Rib Fractures	Yellow	**92%**
17	81	97	99	Fracture of Coccyx	Yellow	**92%**
17	81	97	99	Contusion of Hip	Yellow	**92%**
17	81	97	99	Fracture of Shaft of Femur	Yellow	**92%**
12	77	186	99	Epidural Hemorrhage	Yellow	**93%**
17	101	145	93	Fracture of Sternum	Yellow	**94%**

12	120	114	96	Multiple Rib Fractures	Yellow	**94%**
12	120	104	95	Traumatic Pneumothorax	Yellow	**94%**
15	76	184	95	Unspecified Head Injury	Yellow	**95%**
12	75	184	95	Contusion of Hip	Yellow	**95%**
12	75	184	95	Fracture of Shaft of Femur	Yellow	**95%**
22	63	100	98	Epidural Hemorrhage	Yellow	**95%**
14	116	107	100	Fracture of Sternum	Yellow	**96%**
14	116	107	100	Multiple Rib Fractures	Yellow	**96%**
14	116	107	100	Traumatic Pneumothorax	Yellow	**96%**
14	116	107	100	Fracture of Clavicle	Yellow	**96%**
14	116	107	100	Multiple Fractures of Lower Leg	Yellow	**96%**
12	71	99	97	Fracture of Neck of Femur	Yellow	**97%**
12	115	119	95	Superficial Injury of Lip and Oral Cavity	Yellow	**97%**
14	114	117	97	Unspecified Intracranial Injury	Yellow	**98%**
12	112	155	98	Subdural Hemorrhage	Yellow	**99%**

Table 2. *Survival Probability Function Values for a Series of Clinical Patients*

On figures 2-5, the survival probability function profiles for selected variations in vital parameter parameters are presented.

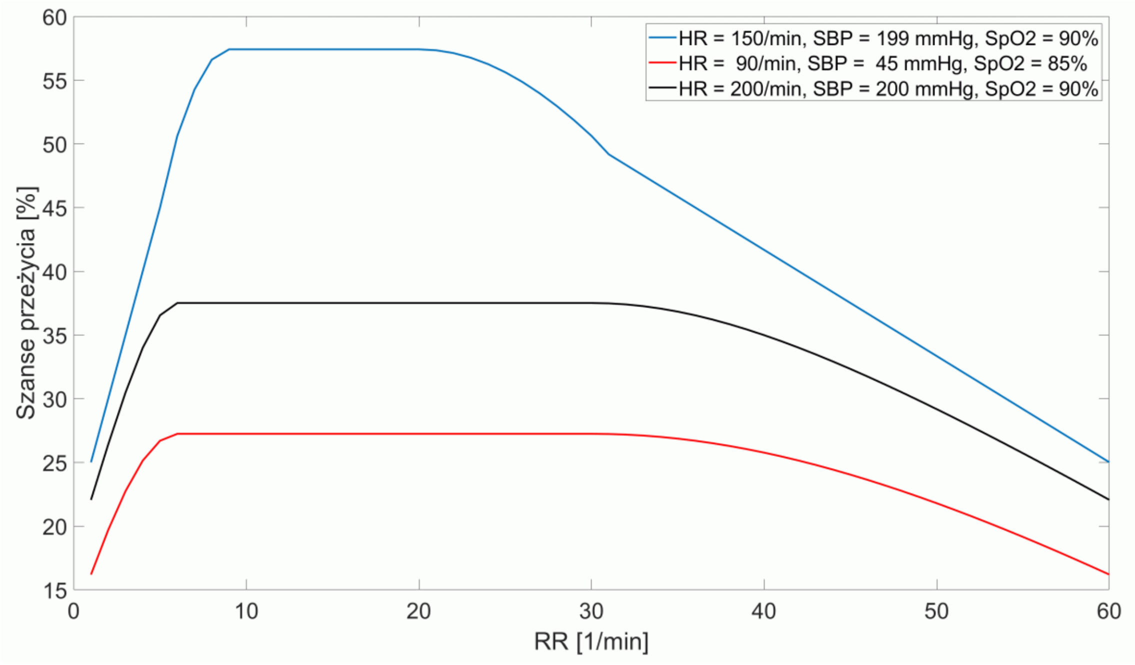


Figure 2. *Survival Probability as a Function of Respiratory Rate*

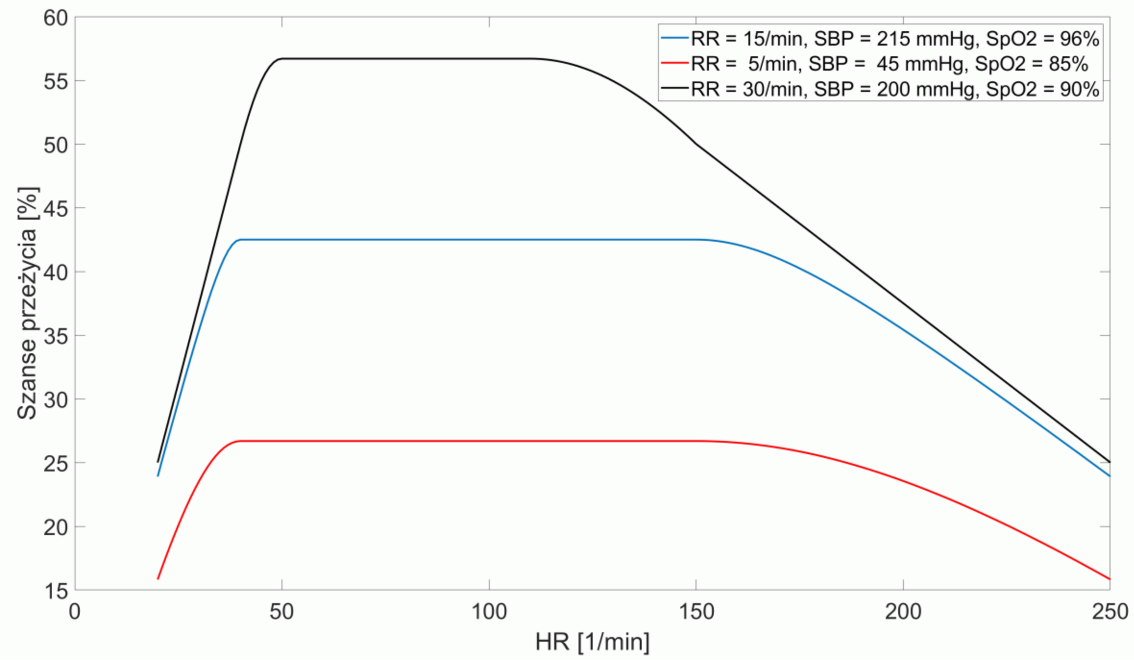


Figure 3. *Survival Probability as a Function of Heart Rate*

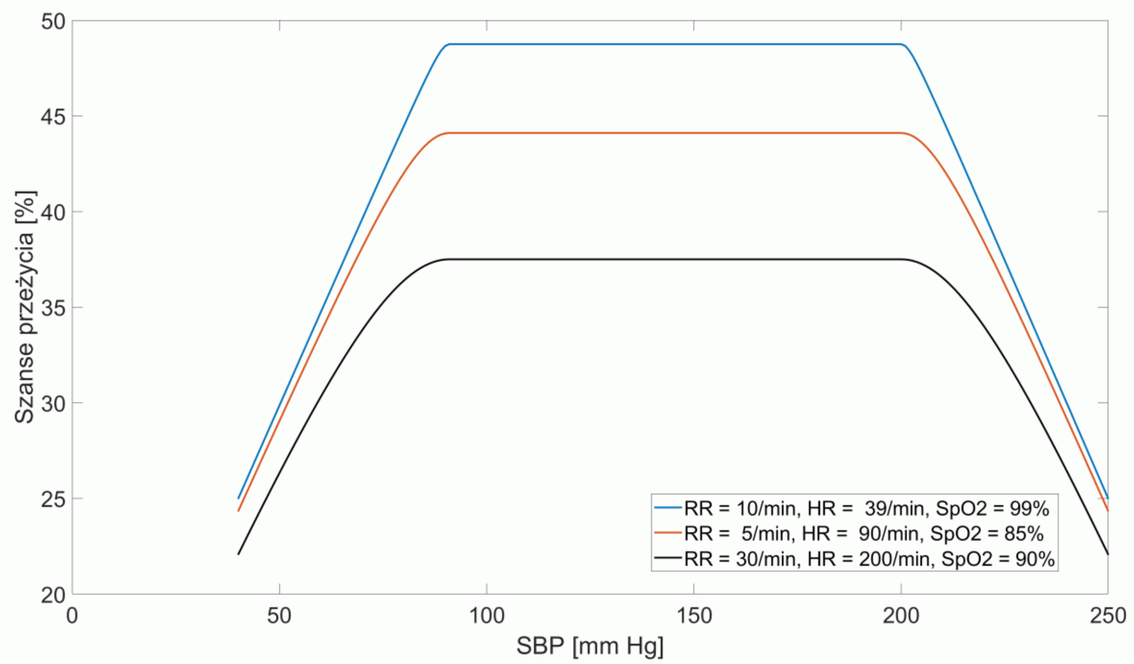


Figure 4. *Survival Probability as a Function of Systolic Blood Pressure*

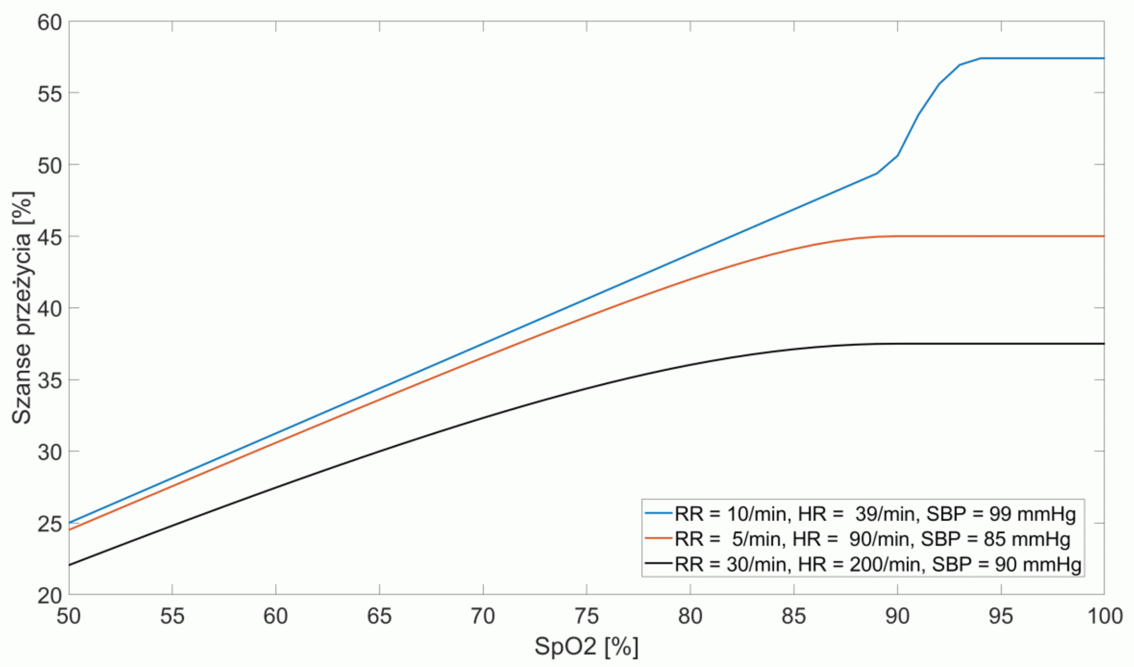


Figure 5. *Survival Probability as a Function of Oxygen Saturation*

The full algorithm (including the calculation of the survival probability function) is applied when all four stable signals are available: HR, RR, SBP, and SpO2, and it makes sense for a stationary soldier. Often in the field, there are cases of "disconnection" of one or several sensors. This may be due to signal loss from a sensor or strong interference that prevents the correct determination of a parameter. In such cases, the assignment to the appropriate group (color coding) still occurs, but the reliability of the result is reduced, and the survival probability function is not calculated. After medical consultations, the following operating variants of the system were adopted:

1. When all four parameters are available, the full algorithm is used (Figure 4.1), and the survival probability function is additionally calculated. The reliability of the triage result is 100%.

2. In the case of the SpO2 sensor being disconnected, the algorithm using only HR, RR, and SBP is applied. The reliability of the triage result is 90%.

3. In the case of the SBP sensor being disconnected, the algorithm using only HR, RR, and SpO2 is applied. The reliability of the triage result is 80%.

4. When both the SpO2 and SBP sensors are disconnected, the algorithm using only HR and RR is applied. The reliability of the triage result is 70%.

5. In the case of the RR sensor being disconnected, the algorithm using only HR, SBP, and SpO2 is applied. The reliability of the triage result is 80%.

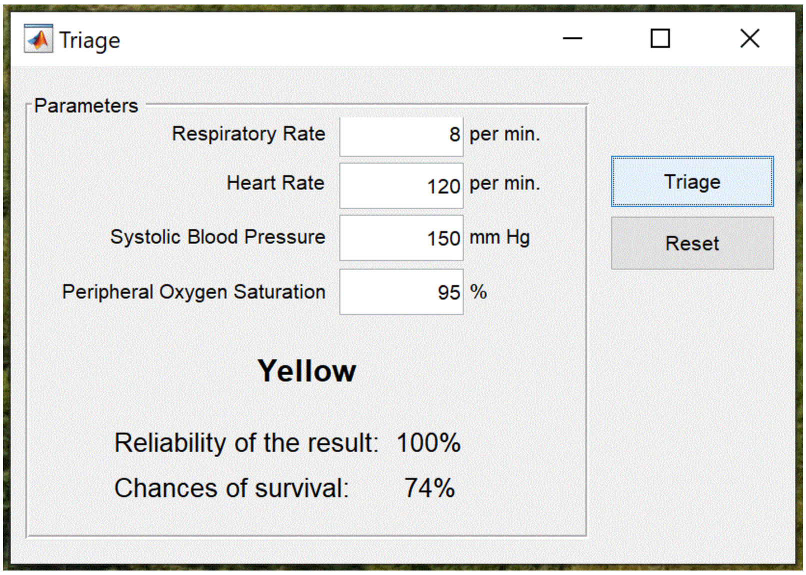
6. When both the RR and SpO2 sensors are disconnected, the algorithm using only HR and SBP is applied. The reliability of the triage result is 70%.

7. When both the RR and SBP sensors are disconnected, the algorithm using only HR and SpO2 is applied. The reliability of the triage result is 60%.

8. When all three sensors (RR, SpO2, and SBP) are disconnected, the algorithm using only HR is applied. The reliability of the triage result is 50%.

9. If the HR sensor is disconnected, the system does not function (regardless of the others) and the casualty is marked in blue. To mark in black, confirmation by a medic at the scene is required.

Figure 6. shows the main screen of the testing program for the triage algorithm in the Matlab environment.



Respiratory Rate 8 per min.

Heart Rate 120 per min.

Systolic Blood Pressure 150 mm Hg

Peripheral Oxygen Saturation 95 %

Yellow

Reliability of the result: 100%

Chances of survival: 74%

Figure 6. *Main Window of the Triage Program in the Matlab Environment*

5 Summary

In this article, a review of the most important vital signs relevant to a medical rescuer in the field of combat was conducted. It was determined that the key measurable and assessable vital signs include heart rate, respiratory rate, oxygen saturation, systolic blood pressure, physical activity, and body position. Based on the first four vital signs, a classification algorithm in the form of a decision tree was proposed, supplemented with a module to determine the survival probability function value, which was implemented in the Matlab environment. After the Triage procedure, the operator is presented with an assessment of the soldier's health in the convention: red (R), yellow (Y), green (G), along with the value of the survival probability function, which assigns a range of 1 – 50% to the red class, 51% – 99% to the yellow class, and 100% to the green class. In the case of the absence of one or more parameters - due to sensor disconnection or strong interference - the value of the survival probability function is not calculated, and the program signals a decrease in the reliability of automatic triage.

The solution proposed in this article appears to be unique both in the civilian and combat environments. The authors, in their analysis of available sources, did not find analogous or similar solutions. It should be noted that this is one of the first approaches of this kind to the issue of triage in a tactical environment. At the same time, the system allows for further expansion, which will enable better monitoring and care of casualties in the PFC (Prolonged Field Care) phase. In this phase, the proposed system - by continuously monitoring the vital signs of soldiers - relieves the medic from the need to repeat the same tasks and allows them to focus on other aspects such as preparing and administering medications, wound dressing, performing key interventions, etc.

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