Open Access Maced J Med Sci **electronic publication ahead of print,**
published on February 12, 2019 as https://doi.org/10.3889/oamjms.2019.119

ID Design Press, Skopje, Republic of Macedonia
Open Access Macedonian Journal of Medical Sciences.
https://doi.org/10.3889/oamjms.2019.119
eISSN: 1857-9655
Review Article

Triage Systems in Mass Casualty Incidents and Disasters: A Review Study with A Worldwide Approach

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Citation: Bazyar J, Farrokhi M, Khankeh HR. Triage Systems in Mass Casualty Incidents and Disasters: A Review Study with A Worldwide Approach. Open Access Maced J Med Sci. https://doi.org/10.3889/oamjms.2019.119

Keywords: Disasters; Triage; Mass Casualty Incidents; Review

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Received: 22-Nov-2018; **Revised:** 29-Jan-2019; **Accepted:** 30-Jan-2019; **Online first:** 12-Feb-2019

Funding: This research did not receive any financial support

Competing Interests: The authors have declared that no competing interests exist

Abstract

BACKGROUND: Injuries caused by emergencies and accidents are increasing in the world. To prioritise patients to provide them with proper services and to optimally use the resources and facilities of the medical centres during accidents, the use of triage systems, which are one of the key principles of accident management, seems essential.

AIM: This study is an attempt to identify available triage systems and compare the differences and similarities of the standards of these systems during emergencies and disasters through a review study.

METHODS: This study was conducted through a review of the triage systems used in emergencies and disasters throughout the world. Accordingly, all articles published between 1990 and 2018 in both English and Persian journals were searched based on several keywords including Triage, Disaster, Mass Casualty Incidents, in the Medlib, Scopus, Web of Science, PubMed, Cochrane Library, Science Direct, Google scholar, Irandoc, Magiran, Iranmedex, and SID databases in isolation and in combination using both and/ or conjunctions.

RESULTS: Based on the search done in these databases, twenty different systems were identified in the primary adult triage field including START, Homebush triage Standard, Sieve, CareFlight, STM, Military, CESIRA Protocol, MASS, Revers, CBRN Triage, Burn Triage, META Triage, Mass Gathering Triage, SwiFT Triage, MPTT, TEWS Triage, Medical Triage, SALT, mSTART and ASAV. There were two primary triage systems including Jump START and PTT for children, and also two secondary triage systems encompassing SAVE and Sort identified in this respect. ESI and CRAMS were two other cases distinguished for hospital triage systems.

CONCLUSION: There are divergent triage systems in the world, but there is no general and universal agreement on how patients and injured people should be triaged. Accordingly, these systems may be designed based on such criteria as vital signs, patient's major problems, or the resources and facilities needed to respond to patients' needs. To date, no triage system has been known as superior, specifically about the patients' clinical outcomes, improvement of the scene management or allocation of the resources compared to other systems. Thus, it is recommended that different countries such as Iran design their triage model for emergencies and disasters by their native conditions, resources and relief forces.

Introduction

One of the symptoms of disasters is that the immediate needs of the community affected exceed the available resources, so the question is how these resources should be used to have the best outcome for the people. Triage is the allocation of limited resources during a disaster. Although the concept of triage applies to all resources, "patient care" is the most commonly discussed field for which the notion of triage is used [1]. Triage is one of the key principles of the effective management of major emergencies [2]. Triage is derived from the French word "trier", which means separating, categorising or classifying, and refers to the categorization, classification, and prioritization of patients and injured people, based on their urgent need for treatment [1], [3]. The process of triage allows the respondents of disaster, who do not have enough resources to treat everyone, to prioritize care services, so that most services are provided to the greatest number of injured people, and this is essentially the philosophy of doing triage in disasters and mass casualty incidents [1], [3], [4]. Triage is usually performed at three stages: the primary triage that is carried out at the scene of the incident by an emergency technician aims at the prompt assessment of the injured person and rapid transfer to the treatment center. Secondary triage which is used when, due to the large extent of the incident and lack of resources in the pre-hospital, the transmission of the injured person has been prolonged in the scene.

In these cases, triage will be done by an emergency doctor or surgeon as soon as the injured person arrives at the hospital. The third triage is performed to prioritise and decide on receiving care services, including transferring to the operating room or the intensive care unit. This step will be done by a surgeon or a critical care specialist [1], [5].

The triage system is used by individuals to determine which groups of the patients should receive treatment and care services based on their clinical status, the prognosis of disease and available resources [6].

Methods

The present study was conducted through a review of triage in disasters and mass casualty incidents, with the aim of identifying triage systems, relevant criteria, and the order of these criteria all over the world. Accordingly, all articles published in English and Persian language journals between 1990 and 2018 were searched based on several keywords including Triage, Disaster, Mass Casualty Incidents in the Medlib, Scopus, Web of Science, PubMed, Cochrane Library, Science Direct, Google scholar, Irandoc, Magiran, Iranmedex, and SID databases in separation and combination using *and/or* conjunctions. Based on this, all English and Persian articles conducted in the world, which discussed triage systems and their algorithms and also were of desirable quality, were included in the study. Accordingly, poor quality studies, those who discussed triage, but did not provide the information needed for triage algorithms and their criteria, or studies that merely discussed the accuracy and the testing of triage systems were excluded from the study.

Results

Based on the search done, triage systems were grouped into three classes including primary triage systems (adults and children), secondary and hospital triage systems. In this study, twenty primary adult triage systems, two primary children triage systems and two secondary triage systems were identified. Primary triage systems that have been identified include START, Homebush triage Standard, Sieve, CareFlight, STM, Military, CESIRA Protocol, MASS, Revers, CBRN Triage, Burn Triage, META Triage, Mass Gathering Triage, SwiFT Triage, MPTT, TEWS Triage, Medical Triage, SALT, mSTART, ASAV. The triage systems identified for children were Jump START and PTT. Moreover, SAVE and Sort triage systems were identified as far as the secondary triage is taken into consideration. In the hospital triage systems, the ESI triage model amongst five-level triage systems, which has a higher level of validity and reliability, and the CRAMS triage system used to triage patients in the emergency units of the hospitals were identified. These systems are described according to the following algorithm.

START triage system

This system is the most commonly used triage system in the United States. This system is also used in Canada and parts of Australia and the Israeli-occupied territories. It was created by the Newport Beach Fire Department and Hoag Hospital in California in 1980 [1]. In this system, all injured adults older than 8 years are evaluated, based on the algorithm of the system in 60 seconds or less (preferably 30 seconds). In this system, the criteria including the ability to walk, respiratory rate, capillary filling, radial pulse and obeying the commands are used. By examining each criterion, the patient will be marked by one of the red, yellow, green and black tags (Figure 1) [7].

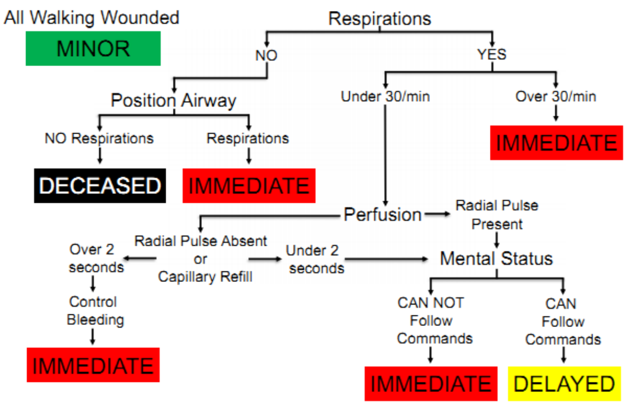

Figure 1: START Triage Algorithm (Bhalla, 2015) [7]

Since the capillary filling criterion in the dark and cold environments in emergencies and disasters is not an appropriate reflection of the circulatory system, this criterion has been omitted in the modified model of the triage system (MSTART) (Figure 2). The only therapeutic measures allowed in this method are opening the airway of the patient and controlling the bleeding by direct pressure on the site of the bleeding.

Reverse Triage

Reverse triage is a method that is commonly used during emergencies and disasters. In reverse triage, injured people with fewer damages and minor injuries are at the priority of receiving services. This is also used in cases, where the treatment team or soldiers, during the war, are injured.

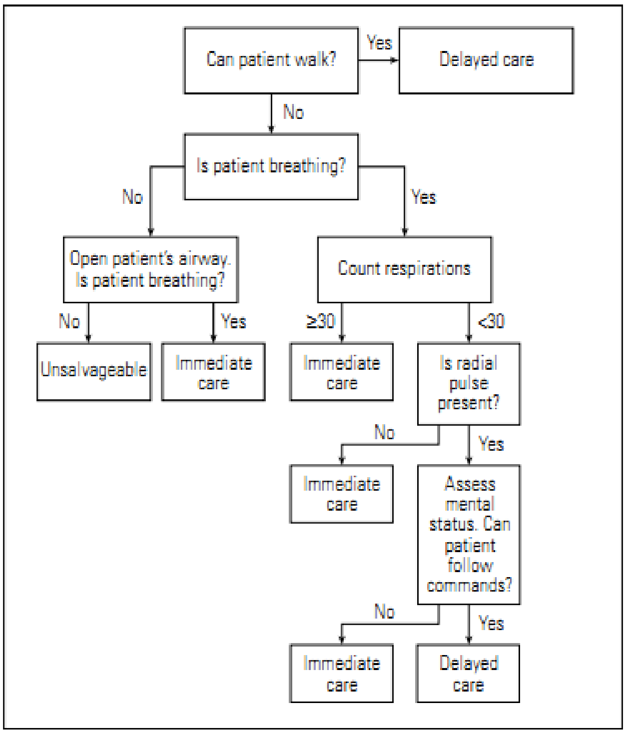

Figure 2: M START Triage Algorithm (Garner, 2001) [14]

Moreover, this kind of triage system is used in the disaster and emergencies, where medical resources are limited, with the aim of returning people as quickly as possible and helping other people [3]. Reverse triage is also a way to increase the capacity of the emergency unit of the hospital during disasters. Accordingly, those patients with mild injuries and those supposed to be without any medical complications for at least 96 hours after discharge are at the top of the discharge list [8].

Military Triage

The main goal of the military triage is to treat and return more injured soldiers to the battlefield. In this method, immediate and rapid classification of the injured people is based on the type and severity of the injury, the probability of survival, as well as the priority of treatment in order to provide the best health care services for the largest number of people [1], [9], [10]. Most military triage systems use T (Treatment) codes including T1, T2, T3, T4 and dead to classify the injured individuals, while others use P (Priority) codes including P1, P2, P3 and P-hold [11].

MASS triage *(Move, Assess, Sort, Send)*

This system is a disaster triage system used in the United States. Although this system is based on the START triage system, it does classify the injured people before individual examination [1]. This includes four stages of moving, evaluating, classifying and transferring. This system, whose algorithm is very similar to the SALT triage method, has four tags: red, yellow, green and black (Figure 3). Allowed therapeutic measures in this model include opening the airway, controlling bleeding, Antidote injections and chest decompression. After performing the actions for this red group, then the yellow and green groups are considered, respectively [1], [12].

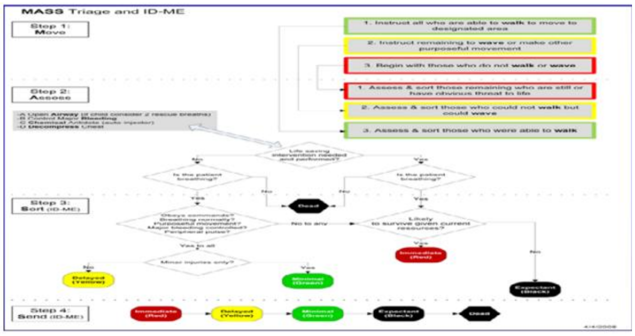

Figure 3: MASS Triage Algorithm (Coule, 2007) [12]

Sieve Triage

Similar to the START method, this method, which is used in parts of Europe, Australia, and the United Kingdom, first uses the walking filter to examine the injured individual, and uses four tags encompassing red, yellow, green and black tags to classify the injured patients (Figure 4) [13], [14], [15].

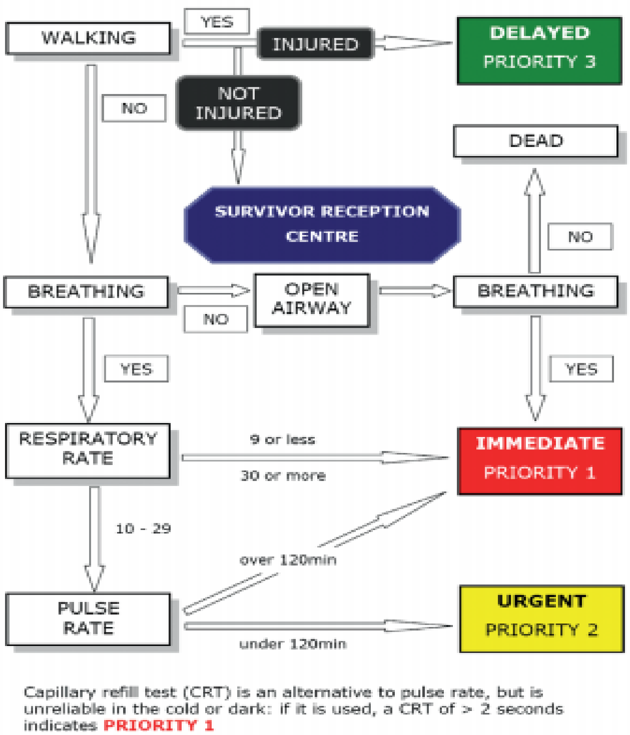

Figure 4: Sieve Triage Algorithm (Smith, 2012) [15]

CESIRA Protocol

This method was designed in 1990. In this method, the injured people fall into three red, yellow and green classes. The red class includes people, who are unconscious and in shock, have bleeding, and ineffective breathing. The yellow class involves patients with fractures of the bones and other injuries, and the green class includes injured people, who can walk [1], [4].

Homebush Triage

This method was designed in 1999 in Australia, which attempts to integrate the triage protocols in that country [16]. This method is based on START and SAVE triage systems [17] and includes 5 classes of triage (Table 1). Although the application of this system was documented in 2002, there are no data on its accuracy and its impact on specific consequences like other triage systems [18].

Table 1: Classification of the injured people according to the Homebush Triage Standard

Homebush Triage Standard		
RED Immediate	ALPHA	Any of the following: Respirations more than 30 breaths/min. No palpable radial pulse. Not able to follow commands.
YELLOW Urgent	BRAVO	Non-ambulatory patients who do not meet black, white, or red criteria.
GREEN Non-urgent	CHARLIE	Able to walk to a designated safe area for further assessment.
WHITE Dying	DELTA	Dying patients: may have a pulse, but no spontaneous respirations.
BLACK Dead	ECHO	I am not breathing despite one attempt to open the airway.

Triage in special circumstances of the CBRN (Chemical, Biological, Radiological, Nuclear)

Although up to now, damages are often caused by explosion, collision or collapse of buildings in most disasters, there are also other probable scenarios, where damages are caused by chemical, biological, radiation, nuclear, and hazardous materials, which have occurred so far all over the world. It is very difficult to design a comprehensive triage system, which is easy to use and scientifically valid for all hazards. In some resources, it is recommended that, under certain circumstances such as incidents of weapons of mass destruction or hazardous materials, in case of occurring mass casualty incidents, a START-based triage algorithm, with a consideration of a series of special measures based on the type of the incident, such as decontamination, use of personal protective equipment and some special clinical considerations should be used. The SALT triage system is proposed with the aim of establishing a comprehensive method for the triage of injured patients at all hazards, but there is little evidence of its effectiveness in CBRN conditions [19].

CareFlight Triage

This method is a tool for rapid triage in mass casualty incidents, in which such criteria as walking ability, obeying the commands, palpable radial pulses, and airway respiration are evaluated (Figure 5). The injured people are placed in four urgent (red), emergency (yellow), delayed (green) and non-salvageable (black) classes.

The noteworthy point is that in this method the criterion of obeying the commands is examined before the evaluation of breathing and pulse rate. This method is one of the fastest triage methods, which takes only 15 seconds to test each patient [3], [14].

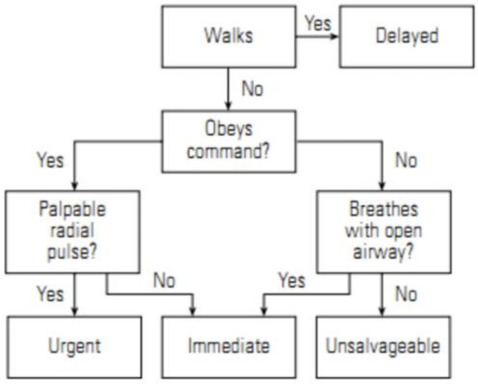

Figure 5: Careflight Triage Algorithm (Garner, 2001) [14]

SALT triage (Sort, Assess, lifesaving intervention, Treatment/Transport)

This is one of the latest triage systems, which was introduced and registered by the CDC in 2008 as a national standard for mass casualty incidents. This process begins by categorising the patients into three groups based on simple voice commands.

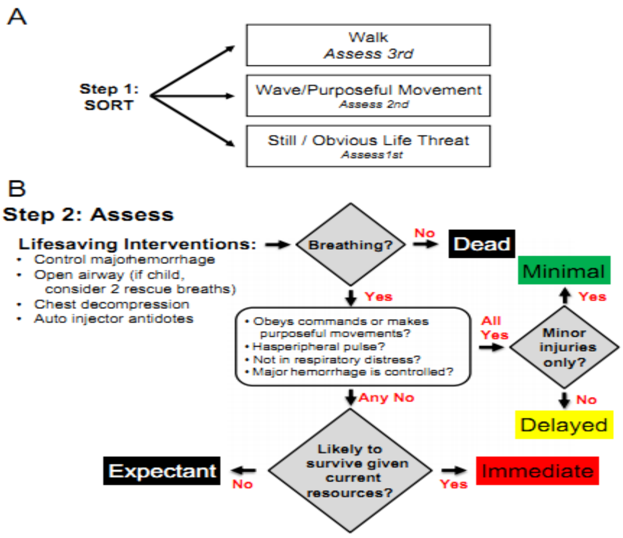

Figure 6: SALT Triage Algorithm (Bhalla, 2015) [7]

The first includes the group of the injured people, who can walk to the area requested by the person performing the triage. The second group is the injured people, who only can shake their hands or feet, and the third group consists of the injured patients, who have no movement or show life-threatening conditions. This third group will be the first group of individual evaluations. The actions recommended in this kind of triage include airway opening, external bleeding control, Antidote injections for some poisonings, and needle thoracostomy for pneumothorax (Figure 6) [4], [7].

STM (Sacco Triage Method)

This method, which is designed based on a mathematical model and is a numerical triage method, considers the resources, based on time and facilities, in addition to the triage of the injured people. In this method, based on the physiological criteria including respiration, pulse and motor response, the injured people are scored, and by the acquired score, the probability of the survival of the injured person or his death is calculated. The first group of the injured people, with a score of 0-4, is tagged with a black label. The injured people of the second group, who have a score ranging from 5 to 8 are likely to survive through interventions. And the patients of the third group with a score of 9 to 12, have a survival probability rate of more than 90 per cent. After rating the injured people, their situation is announced to the incident command centre and subsequently, hospital resources are considered for the treatment (Figure 7) [3], [20], [21].

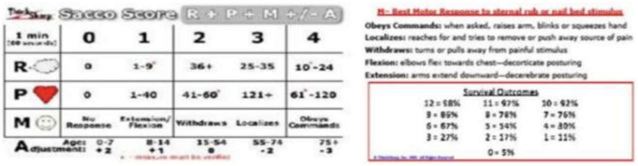

Figure 7: STM Triage Algorithm (Jenkins, 2008) [3]

Burn Triage

In this method, which is used to prioritise injured persons in burn events, the classification of the injured people is based on the severity and level of the burn (Table 2) [22], [23].

Table 2: Classification of the injured people in the Burn triage

Category	Profile
Green group	First- degree and superficial burns
Yellow group	Burns above 30% in people over 5 and under 60 years old
Red group	Second- degree burns in head and neck, genital area and joints Third- degree burns in an anatomical region of the body Burn in people under 5 years of age and over 60 years of age Burn in pregnant women, people with underlying conditions with second- degree burns more than 10%, people with second- degree burns above 30%

META Triage

This method has 4 steps, in which the first and second steps are called Stabilization Triage, and the third and fourth steps are named Evacuation Triage.

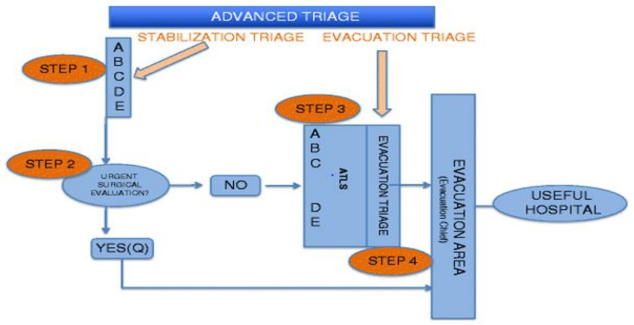

Figure 8: META Triage Algorithm (González, 2016) [24]

In each step, certain actions must be performed according to the algorithm. In the first step, the injured people are placed on the red, yellow, and green classes according to the A, B, C, D and E criteria, and at the next step, the injured individuals are classified based on the evaluation of the surgery and injuries (Figure 8, and 9) [24].

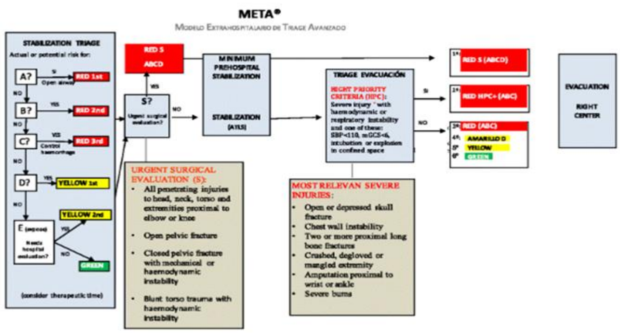

Figure 9: Continuation of the META triage Algorithm (González, 2016) [24]

MASS Gathering Triage

This method is a proposed triage tool for the Australian context in mass casualty incidents that can be used for first responders (Table 3) [25].

Table 3: Classification of the patients in the Mass Gathering Triage (Cannon, 2017) [25]

Category	Description	Vital Signs	Example	Time to see clinician	Rx area
RESUSCITATION	Clinically **unstable** Requiring active **resuscitation** Risk of death or severe morbidity without emergent intervention	*Any red BTF criteria **RR**: <5 or >30 **Spo2**: <90% **HR**: <40 or >140 **BP**: <90 or >200mmHg **LOC**: responding to pain only, or sudden **decrease** of >2 points on GCS **Pain**: severe, uncontrolled pain **Temp**: <34.5 or >40.0C **BGL**: <2.0mmol	• **Respiratory or Cardiac arrest** • **Airway obstruction / choking** • Severe respiratory distress • Severe anaphylaxis • Life-threatening bleeding • Major trauma	Immediate	Resus / Acute +MERT
URGENT	Clinically **stable** At **risk** of deterioration Needs **urgent** intervention Potentially life-threatening presentation	*Any yellow BTF criteria **RR**: 5 – 10 or 25 – 30 **Spo2**: 90 – 95% **HR**: 40 – 50 or 120 – 140 **BP**: 90 – 100mmHg or 180 – 200mmHg **LOC**: Decrease in LOC from alert to responding only to voice, or new onset confusion **Temp**: <35.5 or >38.5C **BGL**: 2.0 – 3.9mmol	• Shortness of breath • Chest pain • Asthma (moderate) • Systemic allergy • Abdominal pain • Hypoglycaemia	<5 minutes	Acute +HCP review
MINOR	Minor injury or illness requiring assessment or treatment only	Normal vital signs	• Wound (minor) • Soft-tissue injury • ?Fractured limb (distal)	<10 minutes	Fast-track +/- HCP
SELF-HELP	Patient could have self-helped if at home	Not required to measure vital signs unless suspicious presentation	Request for: • Band-Aids	<60 minutes	First Aid

Modifiers:
1. Mechanism of injury, i.e. fall >3metres
2. Effects of alcohol and drugs needs to be considered. Abnormal behaviour, especially where there is a serious risk to the patient or others should be up-triaged.
3. Time sensitive medical condition e.g. (i) 12-lead ECG shows ST elevation myocardial infarction; (ii) motor findings suggestive of stroke; (iii) septic shock.
4. Acute effects of exercise may increase RR and HR. This should resolve shortly after cessation of exercise, usually within 5 minutes in healthy individuals

SWiFT Triage (Senior, Without, Families, Team)

This method is a triage tool for disadvantaged older adults during disasters designed to quickly identify the needs of this specific group [26]. This method is designed at three levels and at each level specific actions are taken as shown in Figure 10.

SWiFT tool.

Current date:		Worker's name:	
Name:		DOB:	
DO YOU HAVE FAMILY OR FRIENDS WITH YOU HERE? ☐ Y ☐ N			Confirmed? ☐ Y ☐N
<u>Level 1: Health/Mental Health Priority</u> GOES TO SOCIAL WORK BOOTH IN MEDICAL CLINIC	**A.** Do you have any of the following medical problems: ☐ Y ☐ N **Diabetes** ☐ Y ☐ N **Heart Disease** ☐ Y ☐ N **High blood pressure** ☐ Y ☐ N **Memory** ☐ **Other** **Note:** **B.** Do you take medicine? ☐ Y ☐ N Do you have your medicine? ☐ Y ☐ N **If "No," treat as Level 1**		**C.** Do you need someone to help you with: ☐ Y ☐ N **Walking** ☐ Y ☐ N **Eating** ☐ Y ☐ N **Bathing** ☐ Y ☐ N **Dressing** ☐ Y ☐ N **Toileting** ☐ Y ☐ N **Medication administration** **Any checks, treat as Level 1** Do you use something to help you get around: ☐ **Cane** ☐ **Walker** ☐ **Wheel Chair** ☐ **Bath Bench**
D. Where are you right now? **If Senior cannot or does not answer correctly treat as Level I**	**E.** Name 3 ordinary items and have them repeat them; for example, "apple, table, penny."	**F.** What year is it? **If senior cannot/does not answer correctly treat as Level 1**	**G.** Ask them to repeat the three items you previously mentioned. **If more than one item is missed, treat as Level 1.**
<u>Level 2: Case Management Needs</u> IS REFERRED TO A CASE MANAGER	**A.** Ask them what their major need is right now.	**B.** Do you have a plan for where you will go when you leave here? ☐ Yes ☐ No	**C.** *Income/Entitlements* Are you on: ☐ Y ☐ N **Medicare** ☐ Y ☐ N **Medicaid** ☐ Y ☐ N **SSI** ☐ Y ☐ N **Social Security** ☐ Y ☐ N **Food Stamps** ☐ Y ☐ N **VA Benefits** ☐ Y ☐ N **Section 8 housing funds** **Do you have your documents?** ☐ Yes ☐ No
<u>Level 3: Only needs to be linked to family or friends</u> DIRECTED TO RED CROSS VOLUNTEER	**A.** *Family* Do you need help to find your family/friends? ☐ **Yes** ☐ **No**	**B.** Names: Relationship: Location:	***WHERE IS THE SENIOR LOCATED?***

Figure 10: SWiFT Triage Tool (Dyer, 2008) [26]

Medical Triage Protocol

In this protocol, the walking ability criterion is initially controlled, and those who can walk are classified in the green group. Then, other criteria such as the level of consciousness, arterial bleeding, shock, breathlessness, fractures and injuries of the head and spine, and ultimately pathologies such as myocardial infarction, poisoning, burns, hypothermia, and chest pain are checked and the patient is tagged as red or yellow according to the following algorithm (Figure 11) [27].

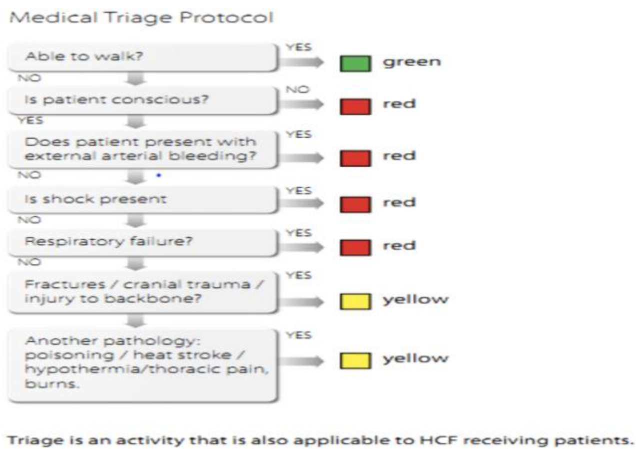

Figure 11: Medical Triage Algorithm (Alexander, 2013) [27]

TEWS triage (Triage Early Warning Score)

This method of triage is a numerical 5- level method, which was designed according to the experts' opinion for the injured people over 12 years of age and above the height of 150 centimetres (Figure 12).

ADULT TRIAGE SCORE								
	3	2	1	0	1	2	3	
Mobility				Walking	With help	Stretcher/ immobile		Mobility
RR		Less than 9		9 - 14	15 - 20	21 - 29	More than 29	RR
HR		Less than 41	41 - 50	51 - 100	101 - 110	111 - 129	More than 129	HR
SBP	Less than 71	71 - 80	81 - 100	101 - 199		More than 199		SBP
Temp.		Less than 35		35 - 38.4		38.5 or more		Temp.
AVPU				Alert	Reacts to Voice	Reacts to Pain	Unresponsive	AVPU
Trauma				No	Yes			Trauma
Over 12 years/taller than 150 cm								

Figure 12: TEWS triage(Wallis, 2006) [28]

The injured person is placed in one of the five classes of red, orange, yellow, green and blue by the final score (Table 4) [28], [29].

Table 4: Classification of injuries in the TEWS triage (Wallis, 2006) [29]

Colour	Red	Orange	Yellow	Green	Blue
TEWS	7 or more	5 - 6	3 - 4	0 - 2	Dead
Target time to treat	Immediate	Less than 10 min	Less than 60 min	Less than 240 min	
Mechanism of injury		High energy transfer			
Presentation		Shortness of breath – acute		All other patients	Dead
		Coughing blood			
		Chest pain			
		Haemorrhage – uncontrolled	Haemorrhage – controlled		
	Seizure – current	Seizure – post ictal			
		Focal neurology – acute			
		Level of consciousness reduced			
		Psychosis/aggression			
		Threatened limb			
		Dislocation – other joint	Dislocation – finger or toe		
		Fracture – compound	Fracture – closed		
	Burn – face/ inhalation	Burn over 20%	Burn – other		
		Burn – electrical			
		Burn – circumferential			
		Burn – chemical			
		Poisoning/overdose	Abdominal pain		
	Hypoglycaemia - glucose less than 3	Diabetic – glucose over 11 & ketonuria	Diabetic – glucose over 17 (no ketonuria)		
		Vomiting – fresh blood	Vomiting – persistent		
		Pregnancy and abdominal trauma or pain	Pregnancy and trauma		
			Pregnancy and PV bleed		
Pain		Severe	Moderate	Mild	
	Senior health care professional's discretion				

MPTT Triage (Modified Physiological Triage Tool)

The method has four tags including red, yellow, green and black, and the injured patients are assessed based on the ability to walk, respiration, pulse and GCS criteria (Figure 13) [2].

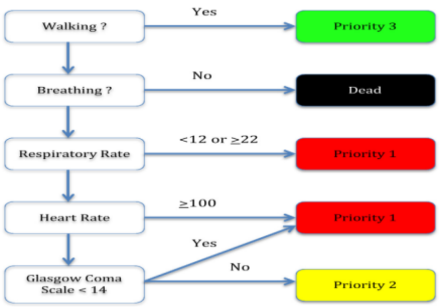

Figure 13: MPTT Triage Algorithm (Vassallo, 2017) [2]

ASAV triage system

Amberg-Schwandorf Algorithm for Primary Triage

In this method, which is considered a primary triage system, the injured individuals are placed in four different classes encompassing red, yellow, green, and black. Accordingly, the injured patient is placed in the black class, when he suffers fatal injuries. In this method, no respiratory rate is considered for breathing. Instead, some criteria for respiratory distress, such as airway obstruction, bradypnea, apnea, dyspnea, tachypnea and cyanosis, are controlled (Figure 14) [30].

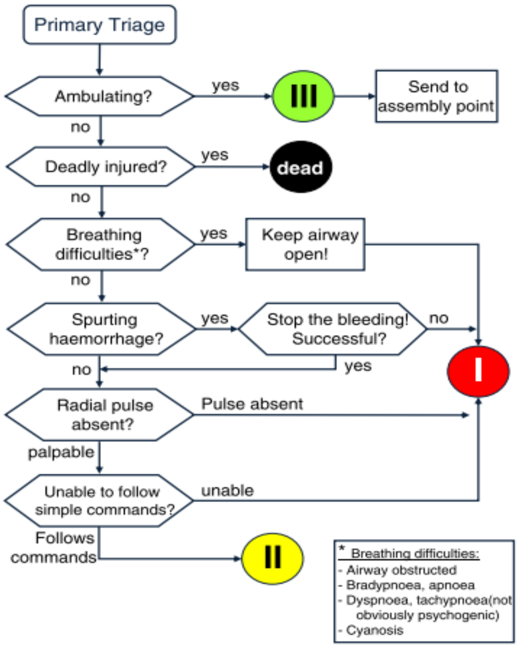

Figure 14: ASAV Triage Algorithm (Wolf, 2014) [30]

Smart Triage System

This method of triage is similar to the START triage system. In this system, it is highlighted that if it is not possible to examine the capillary filling criterion, the radial pulse should be controlled. The injured people are also classified into four categories: red, yellow, green, and black according to the algorithm that sown in Figure 15 [31].

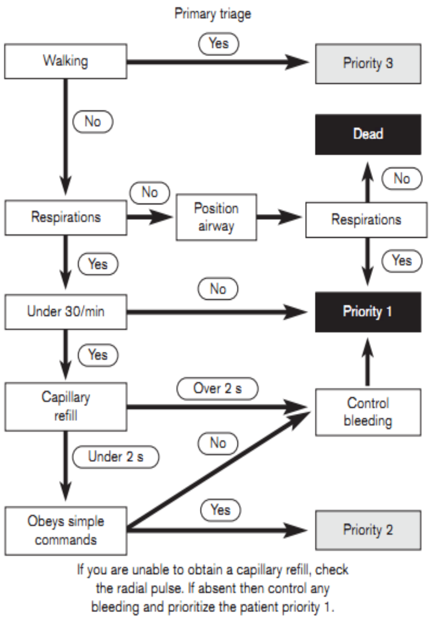

Figure 15: Smart Triage Algorithm (Cone, 2011) [31]

Tactical Triage

In this method of triage, the injured individuals are placed into four classes of green, red, yellow and black (Figure 16). The green group consists of patients, who can walk or have mild damages. The delayed or yellow group includes those patients, who may need surgery, but their general condition allows them to receive any medical or surgical operation with delay and without threatening their life. The immediate or red group includes people, who need immediate medical intervention, including rescue and surgical procedures. The key to the success of the triage is the rapid identification of people with a red tag [32].

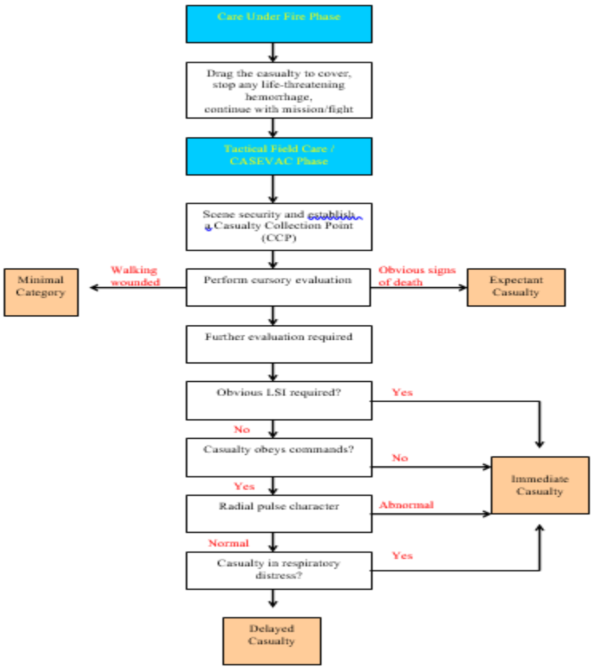

Figure 16: Tactical Triage Algorithm (De Lorenzo, 1991) [32]

Children's triage systems

Why do we need children's triage systems?

There are important and significant physiological and anatomical differences between children and adults, which highlights the need for children's triage systems. Children are more susceptible to head injury, airway obstruction and hypothermia than adults.

Moreover, in children, the respiratory tract is preceded by heart failure. Children have fewer blood counts than adults, and younger children may not have the ability to walk, communicate verbally, and collaborate properly [1]. Two types of these systems have been identified for children, which include Jump START and Pediatric Triage Tape (PTT) [4].

The Jump START triage system

This technique was designed by Dr Romig in 1995 as a tool for the triage of the children under the age of 8, and in 2001, some modifications were made to it, based on the principles of the START triage system [33]. These changes were based on three main differences between adults and children, namely the higher probability of the respiratory failure in children than adults, the number of different breath rates in children, and the inability of the young children to follow verbal commands. In this system, the AVPU was used to assess the level of the children's consciousness, instead of the obeying the commands criterion used in the START triage system (Figure 17) [21].

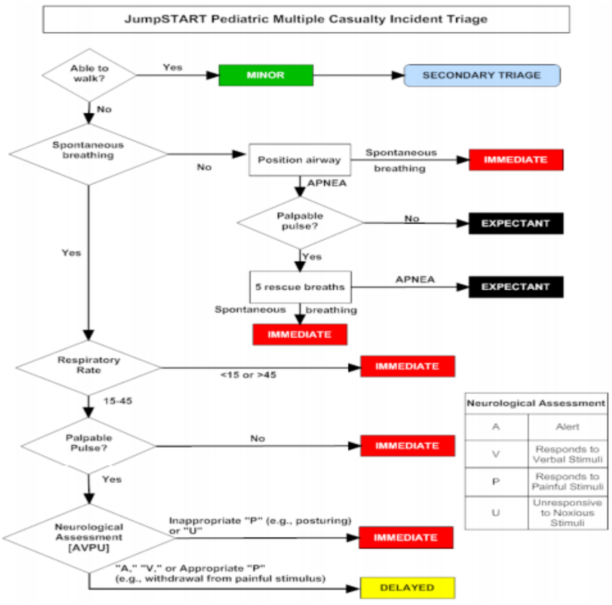

Figure 17: Jump START Triage Algorithm (Romig, 2002) [21]

PTT triage system (Pediatric Triage Tape)

There are three guidelines for this method, based on the height and weight of the infants and children. The first instruction is for the babies with a height of 50 to 80 cm (weighing 3 to 10 kg) (Figure 18). If the child cries and moves his body purposefully, he will be placed in the third priority (delayed). It is necessary to open the baby's airway, in case he does not cry, move and breathe, and if respiration starts after this action, he will be placed at the priority (emergency). Otherwise he would be placed at the last priority (dead). In this guideline, the normal ranges of breathing and pulse are between 20-50 and 90-180 times per minute, respectively. By examining these criteria, the baby is placed in either red, yellow, green or black classes.

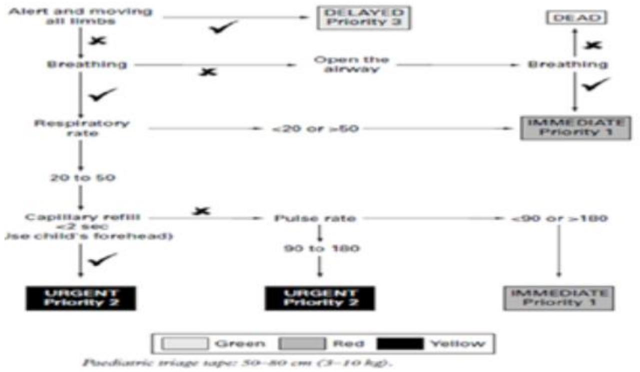

Figure 18: PTT Triage Algorithm in infants with 50-80 cm height [(3 to 10 Kg weight) Hodgetts, 1998] [11]

The second guideline of the PTT triage in a baby with a height of 80 to 100 centimetres and a weight of 11 to 18 kilograms is similar to the first instruction. At this stage, the normal range of respiration and heart rate of the child is 15 to 40 and 80 to 160 times per minute, respectively. In the third instruction, the triage of the child with 100 to 140 cm height (19 to 32 kg weight) is similar to the previous steps. At this stage, the normal number of respiration and pulse rate is 10 to 30 and 70 to 140 times per minute, respectively. In these two stages, it is also necessary to press the child's forehead with a finger to control the capillary filling status [4], [11], [34].

Secondary triage systems

In cases, where the number of the injured people is high, and it is not possible to transfer all the patients to medical centres or hospitals or because of the large extent of the incident and lack of resources in the pre-hospital, the process of transferring all patients from the scene would be prolonged, it is probable that a group of the injured people remains at the disaster scene for a long time. Secondary triage systems are used in these cases as well as at the arrival of the injured patients to the emergency unit of the hospital. The two methods of secondary triage include the SAVE and the Sort triage systems [1].

SAVE Triage

The SAVE method (Secondary Assessment Victim Endpoint) is used to diagnose the patients, who take the most out of the existing care services.

Table5: Criteria in SAVE triage

Criteria in SAVE Triage: Burn Injury, GCS and MESS		
1.Burn Injury: less than 50% chance of survival	2.Head Injury (Adult): Use The Glasgow Coma Score(GCS)	3.Crush Injury to Lower Extremity: Use The MESS Score
70% TBSA Burn	Score 8 or above: Treat better than 50%Chance of a normal or good neurologic recovery	A score of 7 or more: amputate
Age over than 60 with Inhalational injury	Score 7 or less: comfort care only	Score less than 7: attempt limb salvage
Age less than 2 with 50% TBSA Burn		
Age more than 60 with 35% TBSA Burn		

To determine the survival chances and patient classifications, predictive tools of the patient clinical conditions such as limb rescue score, Glasgow Coma Scale (GCS), and survival rate data after burns are used (Table 5, and 6). The injured people, who cannot survive and cannot be treated at the disaster scene, but can be saved if they reach the hospital, will be tagged with a red label. Those patients, who take the most from the available therapeutic interventions, are marked with a yellow tag. Those injured individuals, who can survive even without medical intervention, are tagged with green labels, and finally, the deceased people are labelled with black colour [1].

Table 6: MESS score in SAVE triage

Mangled Extremity Severity Score (MESS)

Type	Characteristics	Injury	Points
1	Low energy	stab wound, simple closed fx, small-caliber GSW	1
2	Medium energy	Open/multilevel fx, dislocation, moderate crush	2
3	High energy	shotgun, high-velocity GSW	3
4	Massive crush	Logging, railroad, oil rig accidents	4
Shock Group			
1	Normotensive	BP stable	0
2	Transiently hypotensive	BP unstable in field but responsive to fliud	1
3	Prolonged hypotension	SBP <90mmHg in field and responsive to IV fluids in OR	2
Ischemia Group			
1	None	Pulsatile, no signs of ischemia	1
2	Mild	Diminished pulses without signs of ischemia	2
3	Moderate	No dopplerable pulse, sluggish cap refill, paresthesia, diminished motor activity	3
4	Advanced	Pulseless, cool, paralyzed, numb without cap refill	4
Age Group			
1	<30y/o		0
2	>30 <50		1

MESS score: six or less consistent with a salvageable limb. Seven or greater amputation generally the eventual result.

From Helfet DL, Clin Orthop 1990 256:80

Sort Triage

This method, which is a kind of secondary triage, has four stages and a numerical system (Figure 19). In this method of triage, patients are tagged according to the score obtained. If the number is 10 or less, the injured individual is placed at the red class, and if the number is equal to 11, he will be placed in the yellow class. A patient with 12 scores will be categorised in the green class [15].

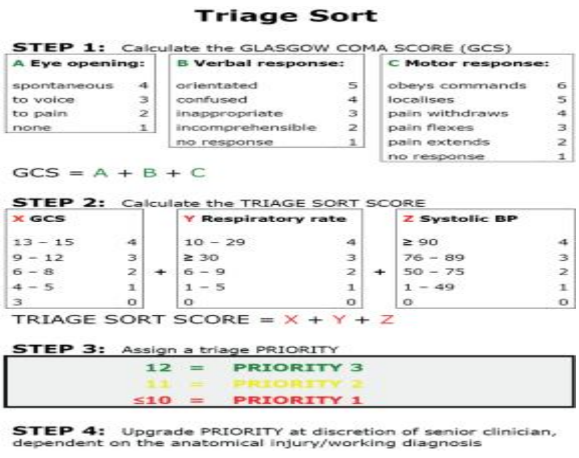

Figure 19: Sort Triage Algorithm (Smith, 2012) [15]

Hospital Triage

The aim of the hospital triage in the emergency department is to place patients in a suitable clinical setting at the right time to receive the appropriate level of health care. There are two, three, four, and five level systems for hospital triage proposed in the world, among which five-level systems including Manchester Triage System (MTS), Canadian Triage and Acuity Scale (CTAS), Australia Triage System (ATS), and and Emergency Severity Index (ESI) have currently shown more validity and reliability scores according to the findings of the previous research [35]. All hospitals should design and develop a program for hospital triage in disaster situations and mass casualty incidents as part of the hospital emergency plan [36].

CRAMS Triage

Circulation, Respiration, Abdominal and Thorax Exam, Motor Response, Speech

This numerical method of triage, as a part of the hospital triage models, is used in some European and American countries (Figure 20). In this method, each criterion is scored from 0 to 2 points. Then, based on the score obtained, the patient with a score of less than 6 will be placed at the immediate class. An injured patient with a score of 7 is placed in the emergency class, and with a score of 8 to 10, he would be categorised in the delayed class [37].

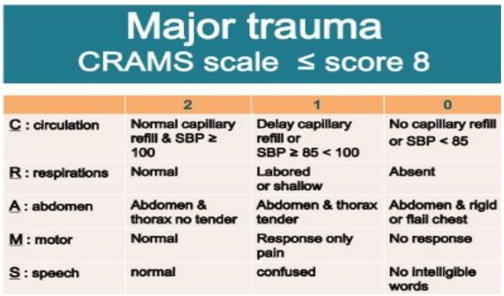

Figure 20: CRAMS triage (Emerman, 1991) [37]

Emergency Severity Index (ESI) Triage

The system was designed in late 1990 in the United States by two emergency medical experts named Richard Weurz and David Eitel [38], [39]. This system, not only determines which patient should be checked first but also indicates which levels of facilities and resources are needed to meet the patient's needs (Figure 21).

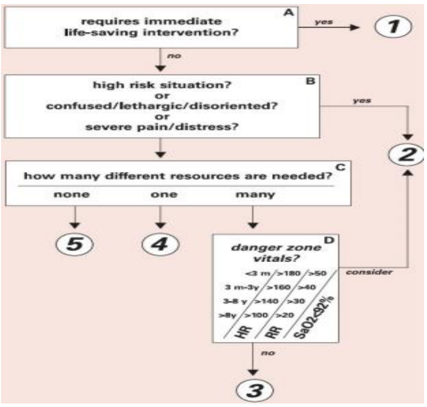

Figure 21: ESI triage algorithm (Eitel, 2003) [38], [39]

Table 7: Comparison of the criteria, their priority and range in different triage systems worldwide

Model	Components and the criteria of the model according to priority - Descriptions required							Model approach
START	1. Ability to walk	2. Respiration	3. Capillary filling	4. Pulse	5. Obeying the commands	The threshold for respiration is 30 times per minute. The pulse has no range or even boundaries, and only its existence or its absence is evaluated.		Algorithmic
Jump START	1. Ability to walk	2. Respiration	3. Capillary filling	4. Pulse	AVPU.5	Breathing between 15 and 45 is normal. The pulse lacks any range. The AVPU criterion is used instead of obeying the commands criterion.		Algorithmic
MSTART	1. Ability to walk	2. Respiration	3. Pulse	4. Obeying the commands	Capillary filling criterion has been eliminated in this model. Breathing below 30 times is considered normal, but there is no range for the pulse criterion and only its presence or absence is controlled.			Algorithmic
Medical	1. Ability to walk	2. Consciousness	3. Arterial bleeding	4. Shock	5. Respiration	6. Traumatic evaluation	The breathing criterion lacks limits and boundaries	Algorithmic
Sieve	1. Ability to walk	2. Respiration	3. Capillary filling	4. Pulse	The respiratory range between 10 and 29 is normal, moreover, the normal range for the pulse is 120 times per minute			Algorithmic
Careflight	1. Ability to walk	2. Obeying the commands	3. Respiration	4. Pulse	In this model, the obeying the commands criterion is controlled prior to the respiration criterion. Respiration and pulse lack any limits or boundaries.			Algorithmic
Mass Gathering	1. Respiration	2. SPO2	3. Pulse	4. Systolic blood pressure	5. Consciousness	6. Temperature and pain	For respiration the range from 10 to 25 and for the pulse criterion the range from 51 to 120, for blood pressure the range of 100 to 180 mm and for the temperature, the range from 35.5 to 38.5 degrees are normal.	Algorithmic

Model	Components and the criteria of the model according to priority - Descriptions required						Model Approach
STM	1. Respiration	2. Pulse	3. Mental status	Walking criterion is not controlled. Breathing ranging from 10 to 24 and a pulse ranging from 61 to 120 are considered natural.			Numerical
MASS	1. Ability to walk	2. Respiration	3. Pulse	4. Obeying the commands	There is no boundary or limit for respiration and pulse. The injured people are evaluated based on the ability or inability to walk in three groups.		Algorithmic
SALT	1. Ability to walk	2. Respiration	3. Pulse	4. Obeying the commands	There is no limit and boundary for respiration and pulse. The injured patients are assessed in three groups based on the ability or inability to walk.		Algorithmic
SAVE	1. Organ rescue scale	GCS.2	3. Burn survival	In the injured people with GCS above 8, and in burns under 50%, young people can hope to survive.			Numerical
Sort	1. Respiration	2. Systolic blood pressure	GCS.3	For respiration, the range of 10 to 29 and for blood pressure the range higher than 90 mm Hg and for GCS the range above 13 are normal.			Numerical
Smart	1. Ability to walk	2. Respiration	3. Capillary filling	4. Pulse	5. Obeying the commands	Breathing below 30 times per minute is normal, but there is no range specified for the pulse, and only its presence or absence is controlled.	Algorithmic
META	1. Respiration	2. Pulse	3. Traumatic evaluation	Criteria A, B, C and D are controlled but the range for respiration and normal pulse is not specified.			Algorithmic

Model	Components and the criteria of the model according to priority - Descriptions required								Model Approach
Homebush	1. Ability to walk	2. Respiration	3. Pulse	4. Obeying the commands	For the respiration criterion, the rate less than 30 times per minute is normal, and there is no specific range for the pulse, and only its presence or absence is controlled.				Algorithmic
CESIRA	1. Ability to walk	2. Awareness control	3. Bleeding	4. Shock	5. Respiration	6. Traumatic evaluation	The respiration criterion has no specific range. Only its quality as well as its presence or absence is controlled.		Algorithmic
PTT	1. Ability to walk	2. Respiration	3. Pulse	4. Obeying the commands	Based on the age and weight, the three ranges including 20 to 50, 15 to 40 and 10 to 30 are normal for respiration. The normal ranges for the pulse criteria are also 90 to 180, 80 to 160, and 70 to 140 times per minute.				Algorithmic
TEWS	1. Ability to walk	2. Respiration	3. Pulse	4. Systolic blood pressure	5. Temperature	6. AVPU	7. Traumatic evaluation	Normal breathing range is 9 to 14 times per minute. The normal range for the pulse criterion is 51 to 100. The normal range for the systolic pressure and temperature is 101 to 199 mmhg and 35 to 38.4, respectively.	Numerical
CRAMS	1. Respiration	2. Systolic blood pressure	3. Motor response	4. Verbal response	5. Abdominal assessment	There is no specific range for breathing, and only the presence or absence of stomach is controlled. The normal systolic pressure is also higher than 100 mm.			Numerical
ASAV	1. Ability to walk	2. Fatal injuries	3. Respiration	4. Control of bleeding	5. Pulse	6. Obeying the commands		Breathing and pulse lack any specific range.	Algorithmic
MPTT	1. Ability to walk	2. Respiration	3. Pulse	GCS.4	The respiration rate is considered to be normal from 12 to 22 times per minute, and for pulse criterion, the range of 100 times per minute is normal. For GCS, 14 and higher is the normal range.				Algorithmic
ESI	1. Respiration	2. Pulse	3.SPO2	There are specific ranges considered for the respiratory and pulse criteria, based on the age range. Moreover, there is a specific range of 92% for the SPO2 criterion.					Algorithmic

The fourth version of the Emergency Severity Index had some modifications and was adopted by the Ministry of Health of Iran as the standard and acceptable method of triage in the emergency department [35]. This system is a useful tool, that can be used in all urban and rural emergency units and general and academic hospitals [38], [39], [40].

Components and approaches of Triage models

According to the results, there are two main numerical and algorithmic approaches for triage in the world. In the algorithmic approach, the injured person is placed in a particular class through examining and controlling each criterion and, if that criterion is normal, the next criterion will be evaluated. But in the numerical approach, the person performing the triage must first control and evaluate all the criteria in the model. Then, based on the score of each criterion, the final score of the injured person condition, which is based on the total score of all the criteria in the model, is specified. According to the final score, the injured individual is placed in one of the triage classes, which are marked with a specific tag. As indicated in this study, each model of triage consists of several criteria and components. Various ranges are considered for similar criteria of different models of triage. Nevertheless the variety of these criteria is also quite obvious, and even in some of these triage models, the same criteria have different prioritisation. For example, although there are similar criteria in the START and CareFlight models, in the former, unlike START, the criterion of the ability to obey the commands is evaluated before the controlling of the airway and respiratory tract. The following table shows the comparative characteristics of the triage systems in terms of the relevant criteria, their priority and the general approach of the model (Table 7).

Discussion

There are many types of triage systems in the world; however, there is no general or universal consensus on how triage should be performed. As triage is a dynamic procedure, there is no fixed rule for it. Accordingly, these systems may be designed based on such criteria as vital signs, patient's major problems, or the resources and facilities needed to respond to the patient needs. One of the most important features of a standard triage system is its simplicity in performing and reliability [41], [42]. In other words, the most effective triage is a method that is easy for staffs to perform, does not need to classify patients and injured people by complex criteria and at the same time determine the prognosis of the patients at an optimal level.

Because of the specific circumstances of disasters and the constraints for conducting high-quality studies, including randomised, controlled trials in real-world conditions, there are little evidence and information concerning the best method for performing triage and the effectiveness of various types of triage methods [1]. The fact that triage categories should not be considered permanent is of particular importance. After prioritizing, patients may not remain in that particular category during the incident. Therefore, considering that the patient's condition is changing, the re-evaluation of the patient should be done. Given the current congestion of the present-day emergency units, a rapid system for the diagnosis and separation of the acute and injured patients seems to be necessary. Hay in a study, conducted on the improvement of the quality of the emergency services and establishing an emergency triage at the Center of Gambia, showed that the implementation of the plan over the past three years has resulted in the improvement of the services, so that the patients have been classified safely and effectively and checked with the least error [43]. To date, no triage system has been superior specifically in relation to the patient clinical outcomes, improvement in the scene management, or allocation of the resources compared to other systems. But it seems that the use of a standardized and uniform system in one area can result in a better interoperability and mutual understanding between health system staff, when responding to disasters and mass casualty incidents [1]. Triage is an important tool in health management during emergencies and disasters. The absence of a common national and international guideline has led to the confusion of the health system staff [44]. In this regard, different countries have designed their own triage systems, according to their local conditions, their resources and their relief forces. Therefore, considering the conditions and characteristics of Iran, the need to design the national triage method is felt [21]. The selection of precise criteria in triage models can reduce the mortality rate, through placing the injured people in the correct class. Moreover, it helps to allocate the limited resources of the medical centers to be given to the injured patients, who really need these resources.

Conclusion

Considering the diversity of the triage models and the criteria defined for each system in the world, it is recommended that each country, considering the specific circumstances of the region, the diversity of the emergencies and disasters, and the facilities and resources of its centres, choose or propose a model with accurate and appropriate criteria, and test the accuracy of that model in case of scenarios or on actually injured people. Considering the lack of an appropriate triage system in its hospitals, Iran also needs to national a triage system, which can be effectively used during emergencies and disasters.

Acknowledgement

We wish to thank all the researchers whose studies were used in this comprehensive review.

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