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# Prehospital Triage Systems in Mass Casualty Incidents:

# Could the Most Commonly Used Systems Be Translated to One?

Degree Project in Medicine

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Gothenburg, Sweden 2021

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## Abstract

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### Background

The field of prehospital triage in mass casualty incidents (MCI) lacks a global consensus regarding what specific triage system to implement. The heterogeneity in available systems poses a threat to the efficiency of the triage process and thus risks an increased mortality of casualties in large-scale rescue operations in a world where both natural and man-made catastrophes are occurring daily.

### Aim

This thesis paper aims to combine a number of pre-existing triage systems made for prehospital context with the intent of producing a global system.

### Method

A novel methodology was investigated: 1) a systematic literature overview, 2) a non-systematic literature search, 3) reading of included articles, 4) content analysis focusing on similarities and differences between systems, 5) presentation of results as a tentative system.

**Results**

31/797 articles were deemed applicable to the project design. In these articles, 17 systems were identified whereof seven were selected for further analysis. The criteria from the final seven systems were compiled, translated and counted for in means of 1/7's. As an end-product of the novel methodology, a system was created of the majority criteria (defined as occurring in ≥4/7 systems).

**Conclusion**

This thesis paper concludes that the studied method of selecting systems, rephrasing criteria, quantifying them and putting together a new system from the majority criteria of included systems is a reasonable approach to the described problem. The final product of this process could be tested out in simulations and compared to present triage systems in terms of speed, sensitivity and specificity. Deeper studies of current knowledge and evidence-based research of each of the criteria and proposed lifesaving interventions is needed together with input from experts in the field.

**Keywords**

*Prehospital, Triage, Mass Casualty Incident, Trauma, Emergency, Surgery*

## Background/Introduction

We live in a world where natural and man-made catastrophes occur regularly. In these events, the need for swift and accurate sorting of wounded, also called "triage", in the field becomes apparent since the burden of the casualties may out-weigh the resources at hand. Globally, different triage systems have been developed leading to a diversity which poses a threat to the efficiency of the process and thereby safety of the casualties. This thesis paper proposes a new methodology for combining any number of the systems in place today with the goal of a final, internationally accepted system in mind.

The word triage stems from the French word "trier" which means "to sort". It has come to refer to prioritizing casualties or patients due to the severity of their injuries or illnesses, often keeping available resources in mind. For centuries this has been a crucial aspect of military medicine and during the last decades also a vital aspect of its civilian equivalent.[1] The birth of the concept of triage can be traced back to a chief surgeon of Napoleons army, Baron Dominique Jean Larrey (1766-1842). Larrey introduced a system where wounded soldiers would be evacuated and treated in order of the severity of their injuries, not their military rank. The system relied on evacuating casualties *during* battle, in contrast to before, when injured soldiers where left where they laid until the battle had abated. The soldiers who survived until the smoke settled could be transported and treated but higher-ranking personnel would always be receiving aid firsthand.[2,3]

The first written example of triage is in a French military manual dating back to 1792.[4,5] Larrey himself summarizes the ideas in his memoirs from the Russian campaign in 1812: "*Those who are dangerously wounded should receive the first attention, without regard to rank or distinction. They who are injured in a less degree may wait until their brethren in* *arms, who are badly mutilated, have been operated on and dressed, otherwise the latter would not survive many hours; rarely, until the succeeding day."*[6]

This type of triage is solely focused on the severity of injuries (the most injured should be helped first) and does not consider *utilitarian* aspects concerning finite resources and the greatest good for the greatest number of people.

During World War I (WWI), the introduction of industrialized weaponry (e.g. machine guns, combat gasses etc.) forced a different approach to triage to be adopted. With the significant shift in warfare technology came large surges of potentially salvageable wounded that greatly overwhelmed medical services and required more resources than were available. This called for a triage perspective that judged not only how badly injured a casualty was but also the time and resources that would be consumed treating that casualty. A single severely wounded soldier or civilian could potentially take time and resources from treating a larger group of people with minor injuries making the move towards a more utilitarian triage a necessity. Branching off the stem of normative ethics, utilitarianism is traditionally credited to 18$^{th}$- and 19$^{th}$-century philosophers and economists Jeremy Bentham (1748-1832) and John Stuart Mill (1806-1873). Basic utilitarianism states that an action is morally right if it produces maximal happiness or well-being for everyone affected by it and is to be considered an opposite to egoism.[7-9] Terms like '*happiness*' or '*well-being*' might be hard to apply to scenarios where triage is needed and can in these instances be viewed as '*least unhappy*' or '*least unwell*'.

Utilitarianism has since WWI become closely connected to triage, especially in triage systems aimed at larger numbers of casualties. In these scenarios, resource scarcity becomes an apparent issue and modern triage systems often allow the loss of a severely injured casualty's life to provide treatment or evacuation to a greater number of casualties with lesser injuries.[3] The concept is also applied to hospital triage to justify the decision of which patients should receive treatment and which should not according to the supposed benefit of treatment.[10]

Another version of military triage also came to during WWI - reversed triage. This idea takes the utilitarian view one step further. It states that the least wounded soldiers always should be treated first to maximize the rate of return to battle among troops. Reversed triage was further developed during World War II and there are records of it being used among both allied and axis forces.[1] There are also records of reverse triage being used in civilian settings. When hurricane Katrina struck in 2005, evacuation of affected hospitals called for identifying and prioritizing patients who were ambulatory; traditionally the least prioritized casualties/patients. These patients were larger in number and more easily evacuated than their more severely ill equals who were evacuated last.[3]

The first record of triage in the civilian sector is considered to be a systematic description of the use of triage in emergency departments (ED) by Weinerman et al published in 1964.[11] Since then, the concept of triage has evolved into an even broader term which can be subcategorized in different ways. Primary, secondary and tertiary triage is a chronological sectioning underlining that triage is a dynamic process where the patient's vital signs can deteriorate over time. Primary triage is most often conducted in the field, subsequent triages may be performed while waiting for evacuation, at the arrival to a collecting area/hospital and then again when prioritizing patients for an intensive care unit (ICU) or surgery. Civilian triage can also be divided according to the situation or location where it is performed. The everyday sorting and prioritizing of patients at an ED differ radically from the more utilitarian triage of casualties from a natural disaster, for instance. This explains the big variance between different, modern triage systems. Furthermore, triage can be divided into hospital and prehospital, a distinction mainly based on the difference in resources available in the field versus a fully staffed hospital.

Triage systems can also be differentiated by placing them on a spectrum according to the ratio of casualties to resources that they are constructed to be performed within. On one side of the spectrum lies the pure hospital triage systems of the ED or ICU which, even in larger surges of patients, will have finite but still great amounts of resources. On the other side of the spectrum is the triage of mass casualty incidents (MCI), defined by the World Health Organization as:

"*an incident which generates more patients at one time than the locally available resources can manage using the routine procedures*"[12]

Or, as stated in the Encyclopedia of Intensive Care:

"*A large incident typically involving many victims and requiring a multi-service response which, by its volume or characteristics, overwhelms or threatens to overwhelm the capabilities of the local emergency response system.*"[13]

The first record of specific, civilian triage for MCI's is considered to be the introduction of the START-system in 1983 by researchers at Hoag Hospital, in collaboration with the Newport Beach, California Fire Department.[13] Between the endpoints of the spectrum lies triage of incidents with multiple casualties but with a moderate level of resources available, a multi-vehicle crash at a highway in a peri-urban area, for instance. In this scenario, available advanced prehospital care, an adequate number of transport vehicles and a presumable easy access to hospitals provides a higher grade of redundancy and a larger surge capacity.

Both hospital and prehospital triage systems rely heavily on four essential factors; *speed*, *precision*, *fairness* and *compatibility*.[14] For prehospital triage systems (especially in the event of an MCI) the element of speed is of importance since there, per definition, will be more casualties than rescue personnel and the post-incident environment might not be secure. Both hospital and prehospital triage also benefit from a fast, simple system that quickly identifies the patients or casualties that require the most immediate intervention/evacuation. The element of speed cannot come at a too big of a sacrifice of precision, though. Generally, the more hastily the triage, the bigger the risk of faulty categorization. Severely injured/ill casualties being assigned to a triage tier too low is referred to as *undertriage* in the literature while over-prioritizing casualties that did not need as immediate attention in the first place is called *overtriage*. Undertriage increases the mortality among casualties because of a prolonged time to extraction, intervention or correct diagnosis. Overtriage could lead to unnecessary consumption of resources; overwhelming of evacuation assets or an ED, for example, which also leads to increased mortality.[15-20]

Prehospital systems allow for lower precision since speed often is of utmost significance while hospital triage often can sacrifice some time to maximize precision, making sure the right priority is assigned to the patient. Fairness in triage is a matter of assessing patients objectively according to a set of parameters of vital signs or mechanisms of injury for instance, not discriminating in terms of age, gender, nationality, religion or any other individual aspect. It can also be applied to a fair distribution of limited resources, connecting to the utilitarian perspective described above. Compatibility is applicable to triage systems being translational over national regions or borders and to prehospital systems being able to seamlessly integrate with its hospital counterparts in terms of categorization etc.

Since its entry on the civilian stage in the 1960's, the area of triage has generated a plethora of different systems for equally as many situations and locations. Even when focusing in on prehospital systems for MCI's, as this thesis paper does, a myriad of examples have been developed. These range from fast, crude algorithms and flowcharts to complex scoring systems requiring exact information on vital parameters, mechanisms of injury and available resources.[21,22] The systems are spread globally and divided not only by national borders, but between regions or even separate emergency medical services (EMS) within the same regions. This heterogeneity poses a particular threat in the event of an MCI which often involve rescue personnel from different organizations, national regions, neighboring countries or across-the-globe allies. In a possible scenario, first responders from different organizations or regions could arrive at an MCI and begin to sort and prioritize casualties according to different protocols. Casualties showing the same vital signs or mechanisms of injury could be given different tiers of prioritization resulting in an unequitable triage. A discussion between EMS-personnel from different regions could arise on the scene, haltering the time-critical job of sorting and evacuating, putting a further stress on the already immensely pressured personnel conducting the triage.[23]

Although it is easily identified, the problem of variability has proven to be a hard one to beat. Several attempts have been made to reach a global or even national consensus in a number of cases without fruition. The main issue making it harder to accept one triage system over another is the lack of actual research behind the origin or refinements of the various systems. When proposing a new system for universal consideration there has often not been much more than anecdotal evidence to its efficacy, making it hard to choose one over the other.[4,13,18,24-26] This thesis paper will explore the possibility of constructing a new MCI triage system using a novel methodology that will select the most recurring criteria from each triage tier in already existing, widespread systems. This approach acknowledges that existing systems are similar in terms of speed, precision and fairness and thereby tackles the last element of triage, compatibility. The majority criteria will reflect the intrinsic uniformity of existing systems, thus highlighting the point that the solution to a global, translational system might lie in a combination of the most popular systems of today.

## Aim

This thesis paper aims to combine a number of pre-existing triage systems made for prehospital context with the intent of producing a global system.

## Method

This rapid evidence review is the product of a qualitative meta-analysis of a number of included triage systems. The method can be summarized as: 1) a systematic literature overview, 2) a non-systematic literature search, 3) reading of included articles, 4) content analysis focusing on similarities and differences between systems, 5) presentation of results as a tentative system. Each step of the methodology was carefully discussed with senior researchers with experience in science and fieldwork to avoid selection and opinion bias of the author.

At project launch, a PRISMA-style literature search was conducted to identify the most frequently mentioned prehospital triage systems designed for use in MCI's published in scientific literature. To find an adequate, Boolean search term, a number of different keywords and combinations thereof was sampled with PubMed as a testbed. The goal was to find a search term that would pick up as many articles regarding prehospital triage in MCI's as possible but still yield a manageable workload for just one researcher. The search term "*((mass casualty incident) OR (multiple casualty incident)) AND (triage) AND ("emergency medical services")*" was selected. The databases PubMed, Scopus and Web of Science was chosen for the final search. Limiting and filtering of the search results was decided on in accordance with the project supervisor. The search results were limited to articles and reviews published between 2000-2020, written in English. Further, in Web of Science the search was conducted with the option of searching 'All Databases' and additional filtering for just articles and reviews (under 'Document Types') was added. Similarly, additional filtering was applied to the search in Scopus; filtering for just articles and reviews (under 'Document Types').

Continuing down the PRISMA workflow-chart, duplicates were identified by exporting all search results into Microsoft Excel, using basic formatting to mark duplicate values in PubMed-ID's and/or titles. The duplicates were subsequently removed. The remaining articles was sifted through, looking at titles and abstracts to pick suitable candidates for the final group. The articles had to focus on prehospital, primary triage in MCI's. More so, on a triage system itself or a comparison of a number of systems. Hence, articles about e.g. a specific MCI where a triage system was *mentioned* but not evaluated or the focus of the article in some other way was discarded. All articles about triage systems for pediatric populations were discarded since the parameters found in those would be extreme outliers compared to the adult ones in the final mapping of overlapping criteria.

At this stage, the remaining articles were reviewed by the author, the supervisor and a professor in healthcare sciences to achieve consensus regarding the selection. The articles were subsequently approved but an additional report, regarding hospital triage systems, was recommended to clarify their potential relevancy in a prehospital, MCI setting. If so, they would have been suitable for inclusion in the project. Twelve systems were listed in the report and were used as separate search terms in PubMed. The search term "*("[FULL NAME]" OR "[ABBREVIATION]") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital)*" was chosen to narrow the results to MCI's and prehospital use. The search results were then screened by the author, reading titles and abstracts.

In the final assembly of articles, abstracts were re-read and full texts studied when needed to determine which triage systems were mentioned. This resulted in a chart displaying the frequency of occurrence. From this chart, the top nine systems were selected for being the ones with a frequency >1 mention. This selection was also a continuation of the aim of keeping the workload at a reasonable level for one researcher and a thesis paper. Since this was not to be a full systematic review, it was decided to not continue further with the PRISMA-workflow. The following step of the workflow chart from PRISMA constitutes further exclusions after reading each article in full text, each exclusion with its own, written motivation. Because the literature search just had the purpose of identifying the most occurring triage systems in scientific publications a deeper analysis of the articles was deemed superfluous. This shift of methodology can be viewed as moving from the initial systematic search modus operandi towards a qualitative content analysis (as defined by Vaismoradi et al.[27]) in the continuation of the method.

When a final assembly of systems had been decided on, the official sources or original articles of these systems were studied to collect data regarding the actual triage process of each system. The triage process is often displayed in an accessible flowchart or algorithm which was identified for each of the nine systems. During this process, two of the selected systems were discarded. These systems did not follow the traditional triage system layout. They were either a part of a much larger system which relied on further triages or a complex system where the categorization would be different from incident to incident depending on the available resources. Continuing, a meta-synthesis[28] was performed where flowcharts were translated into raw text, stating what exact criteria was demanded for a casualty to be placed within a certain category. The criteria of the remaining seven systems were then rephrased to further conform them into a translational dataset so that overlapping could be displayed in a clear manner. After a first rephrasing, merging of near identical criteria was performed.

As the combined criteria of all seven systems had been compiled, rephrased and merged where possible they could easily be separated into general subdivisions under each of the triage tiers. Two of the systems had five triage tiers instead of four like the others. These extra tiers were not added to the final compilation of parameters since they were obvious outliers.

Under each subdivision, the individual parameters were collected and counted for in means of 1/7's. When a final, compiled list of parameters with an equal phrasing had been assembled and counted for, a revised system was produced by combining the parameters of majority (≥4/7) under each triage tier.

## Results

The primary testing of keywords, terms and combinations thereof can be found in **Appx. 1**. Considering the goal of finding as many articles as possible about prehospital triage systems for use in MCI's yet at the same time yielding a tolerable workload for a single researcher the final search term ended up being: "*((mass casualty incident) OR (multiple casualty incident)) AND (triage) AND ("emergency medical services")*"

The search (conducted in the beginning of September 2020) generated 797 hits (Web of Science: 287, PubMed: 266, Scopus: 244) with filters applied. Discarding duplicates resulted in 332 unique articles to be sifted through, looking at titles and abstracts. The screening rendered the number of articles to 31.[4,18,29-57] These articles were studied closer (and read in full text when needed) to identify and quantify the mentioned triage systems.

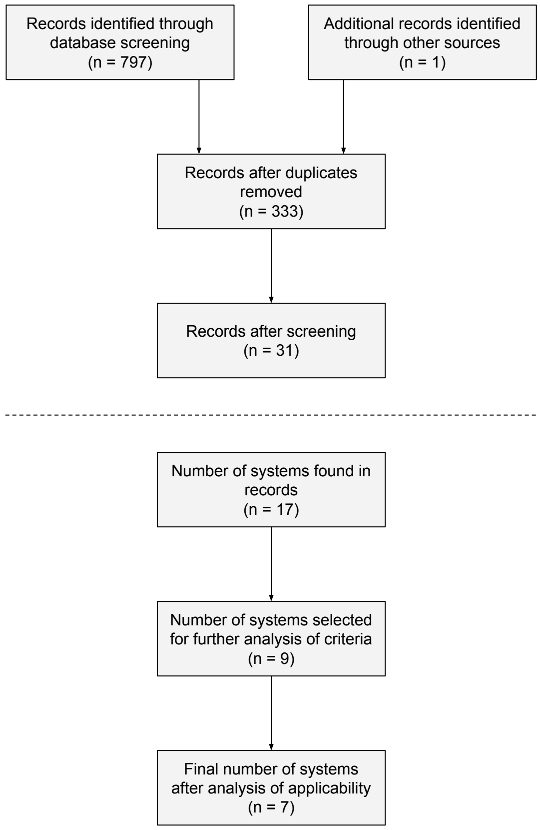


*Figure 1. PRISMA-style workflow, depicting both search and frequency-determining of systems. Produced by the author with the original PRISMA Flow Diagram* ***(Appx. 2)*** *as a template. The final list of records can be found in* ***Appx. 4****.*

The report of the systematic literature search identified 12 hospital triage systems.[58] Eight of these yielded no results when searching PubMed with the search term constructed for the use ("*("[FULL NAME]" OR "[ABBREVIATION]") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital)"*). The remaining four got a number of hits but none of the titles or abstracts indicated prehospital use of the systems in the event of an MCI leading to no inclusion of suggested systems from the report to the final group. **(Appx. 3)**

From the final list of 31 articles a total of 51 mentions of 17 triage systems were found **(Appx. 4)**: Simple Triage And Rapid Transport (START) and Modified START (mSTART), Fire Department of New York modified START (FDNY-START), Modified Physiological Triage Tool (MPTT), Amberg-Schwandorf Algorithm for Primary Triage (ASAV), Sort Assess Lifesaving Intervention Triage/Transport (SALT), CareFlight Triage (CFT), Triage Sieve (TS), Sacco Triage Method (STM), Spanish Prehospital Advanced Triage Method (META), Primary Ranking for Initial Orientation in Emergency Medical Services (PRIOR), Field Triage Score (FTS), Modified Military Sieve (mMS), Military Sieve (MS), Advanced Trauma Life Support (ATLS), Glasgow Coma Scale (GCS) and Chemical Biological Radiation Nuclear (CBRN).

START and mSTART were counted as one since the difference between them only lies in the addition of controlling the radial pulse instead of performing the Blanch test (capillary refill) in cold conditions. Another argument for counting START and mSTART as one is that the two names are used interchangeably in the literature, often just calling the system START when it is the modified version that is referred to. Similarly, TS has undergone evolution to substitute capillary refill for heart rate in cold conditions, this addition did not affect the naming of the system (a Modified Triage Sieve was not mentioned in the literature) and TS is used whether or not the modified version is the one being referred to. In contrast, MS and mMS were to be counted as two separate systems since they differ in criteria range in two out of three total assessments. This reasoning was of importance since it meant that MS and/or mMS were not selected for the final group of systems due to the fact that they were mentioned one time each, had they been counted for as one they would have made the cut.

The top nine of the 17 systems were selected (START/mSTART, SALT, CFT, TS, STM, MPTT, FDNY, ASAV and META) for further analysis of actual system construction regarding criteria and categorization. In some cases, the flowcharts and criteria could be found in an article in the final list. In other cases, the original publication about the system or another official source was found. As the analysis went forth, two of the selected nine (STM and META) were identified as being non-compatible with the study design. STM was removed since it is a mathematical model where given vital parameters can yield different triage tiers from one event to another due to the available resources at that time. META is a system where primary triage is intimately integrated into a larger triage process. Picking the first step out of that concept and not acknowledging the rest of it seemed inappropriate. Additionally, the way both STM and META conducts its primary assessment of casualties differs considerably from the rest of the group, including them in the forthcoming steps of overlapping translational parameters was deemed too impractical. This exclusion meant that seven systems were selected for further analysis. **(Appx. 5)**

The criteria from the final seven systems were collected in a spreadsheet and categorized due to system and inherent triage tier. Two of the seven systems had five triage tiers compared to the rest who had four. The FDNY-START algorithm adds an ORANGE tier to easier identify GREEN and YELLOW casualties with the potential to deteriorate to critical illness. According to the article of origin, ORANGE casualties also have an overrepresentation of chronic medical issues which could make decisions regarding transport easier (since they would not need evacuation to a trauma center)[45]. The SALT system adds an

EXPECTANT/GRAY tier. This tier consists of IMMEDIATE/RED casualties who are not "*Likely to survive given current resources*".[24]

The criteria from each system were then rephrased to make them more comparable and enable overlapping. As all criteria had been through a first rephrasing, obvious merging was identified and performed. **(Appx. 6)** For example, the criterion "*Not breathing with an open airway*" was merged with "*Airway not open*", "*Decapitated, dismembered, transection of torso*" with "*Decapitation or destruction of the torso*" and "*Radial pulse absent*" with "*Peripheral pulse absent*" and so forth. The largest merge was done in the YELLOW/ URGENT/PRIORITY 2 tier. Since all systems were chronological flowcharts with initial division due to ambulation and with all criteria laid out it became obvious that YELLOW casualties simply could be summarized by the criterion "*Non-ambulatory (and not [black (PX)] or [red (P1)])*". This was done instead of displaying every opposite criteria of the RED tier under YELLOW. For example: "Radial/peripheral pulse *absent* = RED, Radial/peripheral pulse *palpable* = YELLOW" etc. just poses as information overflow. Instead, all YELLOW criteria (except one) could be compiled under the merged phrase above.

With all criteria rephrased so that they could be quantified, the criteria were collected and counted for in means of 1/7's. **(Tbl. 1)** The extra tiers from FDNY-START and SALT did not undergo rephrasing since these were obvious outliers. The ORANGE tier of FDNY-START was also excluded based on that it is a form of *secondary* assessment, meant to be used after casualties has been tagged as either YELLOW or GREEN.

Looking at the majority criteria of each triage tier, using the casualty's ability to ambulate or not as a primary regulator to sort out DELAYED/PRIORITY 3 (P3) casualties from the rest was apparent as it was represented in 6/7 systems. The only system that did not contribute to the ambulatory criterion, SALT, actually uses it but in a step that foregoes the individual triage of casualties.

*Table 1. Rephrased, merged criteria with fractions.*

| | |
|---|---|
| ***DEAD/PX*** | **- Non-ambulatory (5/7)**<br>**- Not breathing (7/7)**<br>_after 1-2 attempts at positioning airway (3/7)<br>_after chest decompression (1/7)<br>- No pulse (1/7)<br>- Obvious signs of death (2/7)<br>- Following commands/neurological status (1/7)<br>_unable (1/7) |
| ***IMMEDIATE/P1*** | **- Non-ambulatory (6/7)**<br>**- Breathing/Open airway (6/7)**<br>_only after positioning (1/7)<br>- Respiratory distress (2/7)<br>**- RR (4/7)**<br>_>30/min (1/7)<br>***_>30/min or <10/min (1/7)*** **(full coverage)**<br>_≥22/min or <12/min (1/7)<br>_>29/min or <10/min (1/7)<br>**- Radial/peripheral pulse absent (5/7)**<br>- HR (2/7)<br>_≥100/min (1/7)<br>_>120/min (1/7)<br>- CR >2 sec (2/7)<br>**- Following commands/neurological status (6/7)**<br>**_unable (5/7)**<br>__...or not making purposeful movements (1/7)<br>_GCS <14 (1/7)<br>- Major hemorrhage persistent after attempt to control (2/7)<br>- Likely to survive given current resources (1/7)<br>- Not deadly injured (1/7) |
| ***URGENT/P2*** | **- Non-ambulatory and not [PX] or [P1] (6/7)**<br>- Not fulfilling any [PX] or [P1] criteria (1/7)<br>- More than minor injuries (1/7) |
| ***DELAYED/P3*** | **- Ambulatory (6/7)**<br>- Only minor injuries (1/7) |

*Majority criteria in bold letters. PX, P1, P2, P3 = Priority X etc. RR = Respiratory Rate, HR = Heart Rate, CR = Capillary Refill, GCS = Glasgow Coma Scale.*

This first step is called "Global sorting" and states that casualties that are able to walk should be assessed 3rd after those able to wave/do purposeful movements (2nd) and still/casualties with obvious life threat (1st)[24]. Rephrasing URGENT/PRIORITY 2 (P2) criteria to "*Non-ambulatory (and not [PX] or [P1])*" was successful in 6/7 systems. SALT being the marginal outlier again, since P2 criteria could be rephrased as "*Not fulfilling any [PX] or [P1] criteria (1/7)*", ambulation being left out because of the same reason as above.

A wider spectrum of criteria could be found in the IMMEDIATE/PRIORITY 1 (P1) tier. Rephrasing managed to isolate five main criteria: "Non-ambulatory" (6/7), "Breathing/Open airway" (6/7), "Respiratory rate (RR)" (4/7), "Radial/Peripheral pulse absent" (4/7) and "Following commands/neurological status" (6/7). Counting a respiratory rate without knowing what the determining interval is would be pointless which is why the four suggested intervals were studied closer. 3/4 intervals suggested both a lower and a higher limiter. Having noted this, the one interval that covered the whole spectrum of suggested limiters was selected as a criterion for P1: RR <10 or >30/min. The criterion "Following commands/neurological status" had a subordinated specification which was in majority: "Unable" (4/7), differentiating it from other ways to assess neurological status. In the DEAD/PRIORITY X (PX) tier, two determining criteria were found: "Non-ambulatory" (6/7) and "Not breathing" (7/7). Assessing

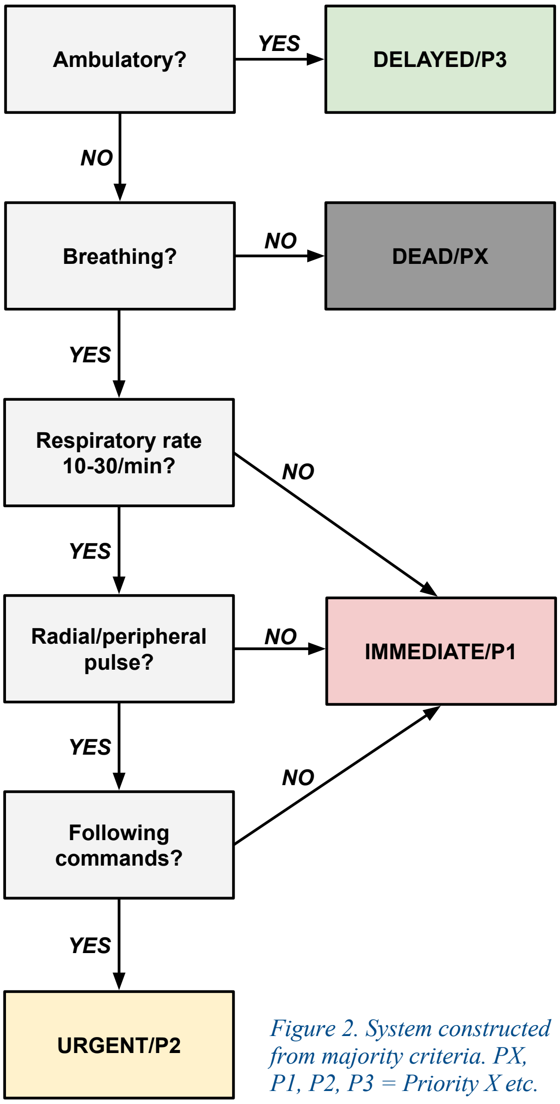


*Figure 2. System constructed from majority criteria. PX, P1, P2, P3 = Priority X etc.*

the ability to walk to determine whether or not a casualty is to be categorized as dead might seem morbid but since ambulation was the majority criterion to single out P3 casualties, all subsequent tiers would have the negated version of that criterion. All systems used breathing or assessment of the airway (with or without intervention) as a determiner for PX.

As a final step, a mock system was constructed of the criteria that were in majority (≥4/7) as a way to illustrate the findings. **(Fig. 2)** The derivation of each step of the final system can be found in the table below. **(Tbl. 2)**

*Table 2. Majority criteria and which system they were derived from.*

| ***CRITERIA*** | ***DERIVED FROM SYSTEM*** |
|---|---|
| Ambulatory: *YES/NO?* | START/mSTART, FNDY-START, MPTT, ASAV, CFT, TS |
| Breathing: *YES/NO?* | START/mSTART, FNDY-START, MPTT, ASAV, SALT, CFT, TS |
| Respiratory rate | START/mSTART, FDNY-START, MPTT, TS |
| _10-30/min: *YES/NO?* | FNDY-START |
| Radial/peripheral pulse: *YES/NO?* | START/mSTART, FNDY-START, ASAV, SALT, CFT |
| Following commands: *YES/NO?* | START/mSTART, FDNY-START, ASAV, SALT, CFT |

## Discussion

This thesis paper has studied the possibility of combining already existing triage systems for prehospital use in an MCI-setting using a novel methodology. The method generated a triage system of combined majority criteria from the included seven systems. The combined criteria system above is to be viewed as a way to display the results, not as an actual proposal for yet another triage system for MCI's. Below, a breakdown of each segment of the combined system which leads to a revised version can be found. This revised version, discussed in reference to relevant research, is the true end-product of the methodology suggested in this thesis paper.

**Ambulation** as the primary divider, sorting out the least prioritized casualties from the rest is a very common criterion in prehospital triage systems aimed at handling greater numbers of casualties.[21] If a casualty can be commanded to walk to a secure rendezvous point it must have sufficient central nervous system (CNS) function to receive, process and elicit a motor response to the command. This also implies that it has enough blood pressure to do so. Also, the casualty cannot be suffering from severe structural damages making movement impossible. This concept is as simple as it is ingenious, which is why it is incorporated in so many systems (all of the final seven in this study, for instance). It is important to remember that this study is limited to *primary* triage. In reality, a second assessment must be made (if possible) as soon as P3-casualties arrive at a designated collecting area since initially ambulatory casualties stand a risk of deteriorating quickly.[13,17]

**Breathing/open airway** as a deciding factor for categorizing casualties as PX is also a common criterion in MCI triage.[21] The phrasing differs, but the general idea is that if the casualty is not breathing by itself the resources required to try to resuscitate it cannot be guaranteed in the event of an MCI. This makes for a wide inclusion of underlying causes from a mechanical airway obstruction to a clinically dead casualty that is not breathing. Several systems allow for 1-2 attempts of a lifesaving intervention (LSI) at this stage, LSI's are discussed further below.

The hierarchy of assessing the airway first is a well proven concept, stemming from the training program Advanced Trauma Life Support (ATLS) developed in the 1970's that has since spread worldwide.[59] Put in simple terms, if the brain cannot get oxygen, the other organ systems down the line does not matter since the patient will die. The ATLS system is based on a mnemonic, *A B C D E*, (Airway maintenance with cervical spine protection, Breathing and ventilation, Circulation with bleeding control, Disability/Neurologic assessment, Exposure and environmental control) that conducts in what order the assessment of a patient should be made and that if a problem is found it has to be addressed before moving on.

**Respiratory rate** (RR) coincides with the second point of assessment of the ATLS system (B - Breathing and ventilation). In the perspective of MCI triage it has the goal of finding casualties that are breathing and thus are alive (alive in the MCI triage definition; can be saved/not PX) but might suffer from a primary injury affecting the airways/lungs or a secondary injury that manifests as a deviant breathing pattern. Examples of primary injuries that affect the RR are direct trauma to the thorax (flailing chest, hemo-/pneumothorax etc.) or inhalation burns/smoke related injuries. An example of a secondary injury that affects the RR is major hemorrhage (hypovolemia) resulting in a physiological response manifesting as tachypnea.[60] It makes sense that injury resulting in altered breathing patterns should be prioritized higher than injuries that do not since the structural and/or physiological causes are generally severe, requiring immediate attention.[61,62]

Assessing the breathing by counting respirations per minute has obvious shortcomings. First, one of the main goals of triage in the MCI setting is that it is supposed to be fast.[14] Checking any parameter in a way that is not entirely binary in its result (as in: "*Breathing: YES/NO?*") takes time. Stopping to count respirations in a conceivably loud, stressful and weather affected surrounding might take several minutes.[17] The RR might be very dynamic in its frequency so that the rate, when being assessed, does not give a fair picture of the actual condition of the casualty. It is highly plausible that the casualty being assessed is under severe psychological stress from the MCI itself resulting in tachypnea or hyperventilation that does not come from life threatening injuries. The casualty could also be in psychological shock from realizing that it is severely injured which, on its own or in combination with the injury, drives a psychogenic hyperventilation. Counting an RR also demands an interval of acceptable values. No matter what the chosen interval is, there is always going to be gray areas (the casualty with RR = 29/min when the upper limit is set to 30/min, for instance). The interval chosen for the final system was just the interval that covered the whole spectrum of the four alternatives. START/mSTART does not have a lower limit, just >30/min, FDNY-START has the interval of 10-30/min, MPTT 11-22/min and TS 9-30/min.[17,44,45,63]

What we really get to know by counting an RR is only if the casualty is brady- or tachypneic but, as stated above, it would rather be of value to know if the breathing is compromised in ways other than frequency (dyspneic or sudden apneic episodes, wheezing, severe coughing with expectoration etc.). This could all be summarized in a criterion with a binary answer: "*Respiratory distress: YES/NO?*" which would be more aimed at assessing the ***quality*** of breathing instead of the ***quantity***. This idea can be recognized in two of the systems in the final group, SALT and ASAV. SALT poses the question "*Not in respiratory distress?*"

while ASAV asks "*Breathing difficulties?*" with a short definition written in close proximity to the main flowchart.[24,48]

To summarize, taking the time to assess an RR with a somewhat arbitrary interval of acceptable values merely results in an assessment of quantity of breathing at that precise moment. Quickly assessing if the casualty is in respiratory distress or not seems favorable both considering time consumption and sensitivity to detect life threatening injuries. It does, on the other hand, require some level of basic medical training to judge if a person is in respiratory distress or not, leaving out the possibility for other personnel (than medically trained) to conduct the triage. A way around this problem would be to write out a few examples (as previously described regarding the ASAV flowchart).

**Radial/peripheral pulse** is used as a proxy to estimate blood pressure and coincides well with the third level of assessments in the ATLS system (C - Circulation with bleeding control). An estimation of blood pressure is of value since a hypotensive trauma casualty has a high risk of life-threatening external or internal hemorrhage. The matter of hypotension from hypovolemia gives a twofold yield in trauma casualties:

1) *Casualties with life-threatening internal bleeding that needs to be tagged as P1 for immediate evacuation and surgical intervention at a hospital.*

2) *Casualties with life-threatening external bleeding that hardly needs their radial pulse checked to be assessed (gushing arterial bleeding tends to be obvious). They need an intervention in the field (more on LSI's below), immediate evacuation and surgical intervention at a hospital.*

Historically, a palpable radial pulse has been equated to a systolic blood pressure (SBP) of >80-90 mmHg[17,22,44] and an SBP of <90 mmHg is widely taught as a sign of shock[64] or the limit of clinical hypotension. The broad term of shock is applicable to the trauma casualty primarily as a function of hypovolemia due to major hemorrhage. Hemorrhage-induced hypotension in trauma patients has been found to be a predictor of significant mortality.[65] This is the main reason to assess the radial pulse; to ask the question: "*Hypotension (due to hypovolemia): YES/NO?*"

The idea of a palpable radial pulse being equitable to an SBP of >80 mmHg stems from the first edition of the ATLS program, published in 1985.[66] The program states that a palpable carotid pulse equals an SBP of 60-70 mmHg, if a femoral pulse can be palpated as well then the SBP lies somewhere between 70-80 mmHg and a palpable radial pulse equals an SBP of >80 mmHg. This paradigm was quickly rejected[67] due to the lack of data to support it and the guidelines were removed from subsequent iterations of the program. Somehow though, these ideas of pulse palpability and its proxy as levels of SBP has stuck throughout the decades since and is still today a subject of discussion and controversy.[60,68-71] Another issue lies in the fact that some sources suggest that an affected SBP is a very late sign of hypovolemia, implying that when changes occur, it might be too late for successful interventions, especially in the prehospital setting.[72] The alternative, to time capillary refill in seconds (as in the earlier iterations of START and TS) is very condition dependent (cold weather, poor lighting) and has also been considered a highly insufficient substitute for blood pressure for decades.[73]

Uncontrolled hemorrhage stands for a significant amount of civilian trauma-associated and military battlefield deaths. Numbers as high as 80% of civilian trauma deaths has been linked to uncontrolled hemorrhage while the same source account up to 50% of deaths on the battlefield to the same.[74] Another source looked at deaths on the battlefield from 2001-2011 and found that 24.3% were potentially survivable injuries whereof 90.9% were associated with hemorrhage.[75] All of this obviously supports *some* form of blood pressure assessment in the MCI triage. To demand the use of a sphygmomanometer in the event of an MCI is out of the question. Not only does it require a stethoscope (and quiet surroundings) in addition to the blood pressure cuff, it also takes an impractical amount of time.[74]

Since no other assessment of blood pressure is available without equipment, the palpation of the radial pulse will probably keep its place in future prehospital triage systems. At least, it seems rational to prioritize a casualty *without* a palpable radial pulse higher than one with a palpable one. To differentiate the casualties with (a high probability of) an internal bleed from the ones that need an intervention in the field (the ones with a life-threatening external bleed) an additional question could be added, as described in the ASAV and SALT systems.[24,48] First asking for: "*Major external bleeding: YES/NO?*" and if: YES, proceed with an LSI while if: NO, proceed with "*Radial pulse palpable: YES/NO?*".

**Following commands** also trails the ATLS algorithm, matching the fourth step (D - Disability/Neurologic assessment). The seemingly elementary assessment of whether a casualty can follow commands or not actually tells us a number of things. Someone who can follow a simple command (such as: "Can you show me where it hurts?", "Can you tell me where you are?" or merely "Can you wave your hand at me?") can receive and process auditory information and then turn it into a verbal or motor response. Being able to follow commands suggests that neither is the flow of oxygen critically impaired, nor is there substantial structural damage to the CNS or the routes thereto. This assessment of verbal or motor response to stimuli is a part of the Glasgow Coma Scale (GCS). The GCS, first described in 1974 by Teasdale and Jennett[76], is a scale for evaluating the level of consciousness in patients with acute brain injury. Especially the motor component of the scale has been found to be a predictor of both the need for an LSI (together with a weak or absent radial pulse)[74] or the risk of dying[77] in in studied groups of trauma patients. The criterion to follow simple commands was supported in some way or another in all the final seven systems and can also be found in several other triage systems[21] that were not included in this analysis.

*Table 3. Systems and LSI's.*

| ***SYSTEM*** | ***LSI*** |
|---|---|
| START/mSTART | Positioning and repositioning (if needed) of airway |
| FDNY-START | Opening of airway |
| MPTT | None |
| ASAV | Keeping airway open |
| | Stopping bleeding |
| SALT | Controlling major hemorrhage |
| | Opening airway (2 rescue breaths if child) |
| | Chest decompression |
| | Auto injector antidotes |
| CFT | None |
| TS | None |

*LSI = Life Saving Intervention.*

**Lifesaving interventions** were included in 4/7 systems in the final group. **(Tbl. 3)** The question of LSI's or not in a triage system for MCI's boils down to two sub-questions;

1) *Who will perform the triage?*

2) *What resources/equipment are available in the field?*

The answer to the first question is somewhat a matter of triage philosophy. Should triage be strictly limited to medical personnel or should volunteers or even bystanders be able to help out? Several countries have legislation concerning who exactly can make such decisions regarding life and death. Also, from more of an ethical point of view; should someone without medical training and insight into available resources be responsible for making such choices? A way around the pressure of decision-making lies in the simplicity of the triage system. A triage system in its simplest form should be usable for anyone but that would require a redundancy level that might not provide correct prioritization from a strictly medical point of view. Correspondingly, a system that is so uncomplicated that *anyone* could conduct the triage leaves absolutely no room for LSI's performed in the field. All LSI's are not equal in regard to what medical training they require but all of them require some.

Looking at the LSI's in the table above, using an antidote autoinjector is an elementary intervention as long as it comes with an accessible manual of operation and instructions of acceptable injection sites. The decision that all casualties should receive an antidote still has to come from a medical professional but the injection itself could be performed by anyone. Controlling major hemorrhage by applying a tourniquet[78] or direct pressure to an extremity is also seemingly straight-forward while attempting to stop a gushing abdominal wound in a satisfactory manner requires more training. The same goes for airway opening and control; to adequately position the casualty's head is not necessarily complicated, but to judge whether or not the positioning is good enough to tag a casualty as PX when breathing does not start is not a call to make for someone without extensive medical training. Performing a needle or tube thoracostomy in the field to decompress a suspected hemo- or pneumothorax ranks as the most complex of the LSI's in the table above. This demands definitive medical training, sufficient conditions and equipment.

The answer to the second question is closely linked to the first. As stated earlier, a triage system for MCI's must be constructed with austere conditions and minimal equipment requirements in mind. This is reflected in the table of LSI's; the positioning of the airway is the LSI in majority since it is performed without equipment and is a fast intervention. As described above, major hemorrhage accounts for a substantial amount of preventable trauma deaths which warrants at least an attempt at controlling the bleeding prehospitally. This could also be made with minimal equipment; make-shift tourniquets can be made from clothing, direct pressure can be applied by bystanders, another victim or, in some cases, even the casualty itself. Field packing of wounds to the abdomen or proximal portion of limbs ranks higher not only in training required but also in equipment demand and time consumption. The matter of antidote administration depends on regional resources and stockpiles and that the contaminating agent has to be identified beforehand. Putting needle or tube thoracostomy as an LSI in the triage algorithm would require that every person conducting triage would be trained to and carry with them the equipment to perform the intervention.

The most LSI-heavy system of the final seven, SALT, states that no LSI's should be performed without sufficient medical training and resources[24]. Adding this disclaimer to a future, combined triage system is a way around the restrictions of LSI's. Since MCI triage is traditionally aimed at medical personnel conducting it, at least airway positioning and controlling of hemorrhage should be allowed. To further cover contaminated events, a future system should also allow for rapid administration of antidotes when needed.

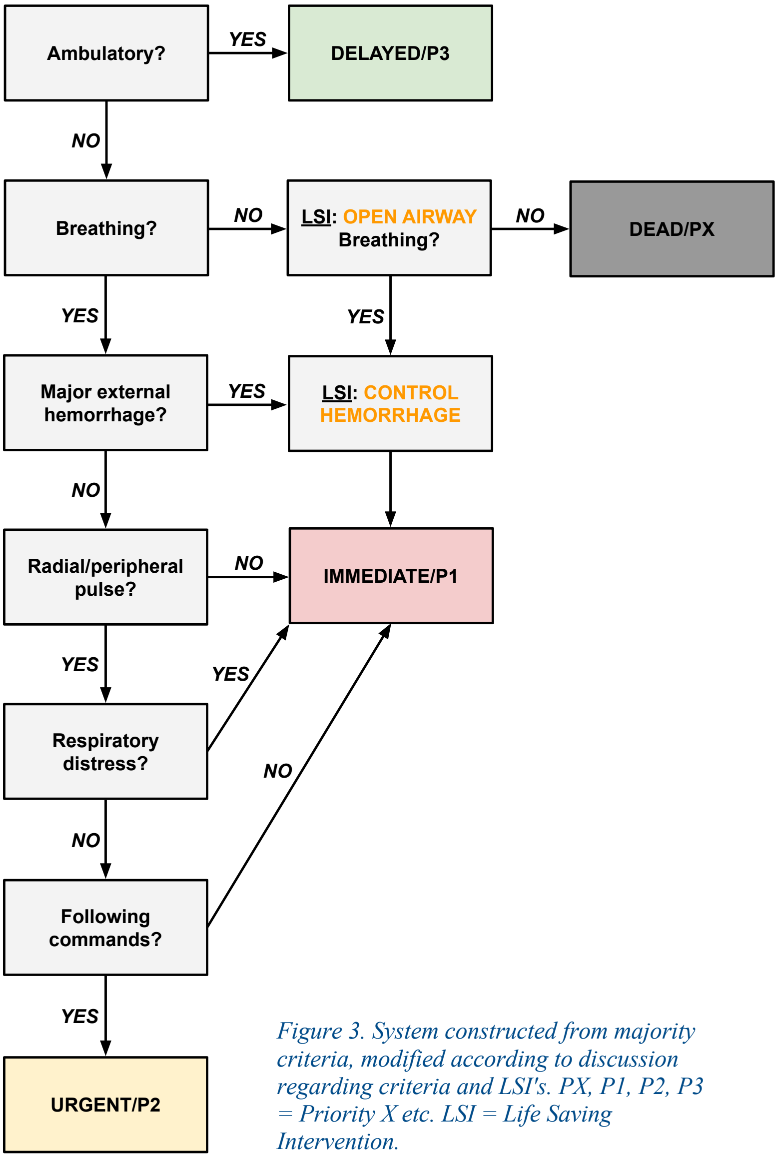


*Figure 3. System constructed from majority criteria, modified according to discussion regarding criteria and LSI's. PX, P1, P2, P3 = Priority X etc. LSI = Life Saving Intervention.*

**To summarize** the discussion about the system constructed out of majority criteria: a more nuanced system would probably emerge from research with greater resources that could include a wider array of existing triage systems. The value of the different stages of the algorithm can all be discussed but all of them can be justified at the moment. Above, a revised version of the combined criteria system can be found, modified according to the discussion above. **(Fig. 3)** This variant is to be viewed as a final step in the methodology of this thesis paper: discussing, reviewing and modifying the majority criteria system. If no further research was to be made, this would still be a highly viable, more nuanced alternative to existing systems.

**Chemical, Biological, Radiation and Nuclear (CBRN)** is a frequently used term when discussing triage in the MCI setting. Adding a layer of contamination of both casualties and incident site to the triage process complicates it exponentially. Several currently widespread MCI triage systems have not been studied for use in these situations.[4,47,79] A number of specific triage systems for CBRN exist[21] but none of these made the final selection in this analysis. Of the final seven, only SALT lists a specific intervention that could be linked to an CBRN-scenario; the administration of antidotes (discussed above). However, all MCI triage systems analyzed here depend on vital parameters or physiological criteria for the prioritization of casualties. It seems plausible that the CBRN casualty would have equally as deranged vital parameters as the trauma counterpart. Instead, the CBRN-scenario's prime challenging factor concerning primary triage is that it would have to be conducted wearing hazardous material (hazmat) protection gear, making some assessments impossible.

Imagining conducting triage using the modified combined criteria system of this thesis wearing full hazmat protection gear; checking if a casualty can walk or if it breathes is possible. As discussed above, counting a respiratory rate will probably not give much information, certainly not when aerosol or gas-form irritant or blistering agents have been used (because of coughing, wheezing, psychogenic tachypnea etc.). Again, identifying *respiratory distress* to assess *quality* of breathing instead of *quantity* seems like the way to go. Palpating for a radial pulse with thick, rubber coated gloves is impossible, making that assessment of the combined criteria system unfeasible. Applying a tourniquet or some other ad-hoc solution to stop major external hemorrhage, is probably possible, keeping the suggested question of "*Major external hemorrhage: YES/NO?*" in the CBRN application of the modified combined criteria system. Verbal communication might be impaired when using respiratory protection apparatuses but to gain a general idea of whether the casualty is able to follow commands seems imaginable. **(Fig. 4)** Envisioning the application of any MCI triage system in an CBRN-setting is fairly easy in theory but requires extensive, further research and input from both civilian and military experts.

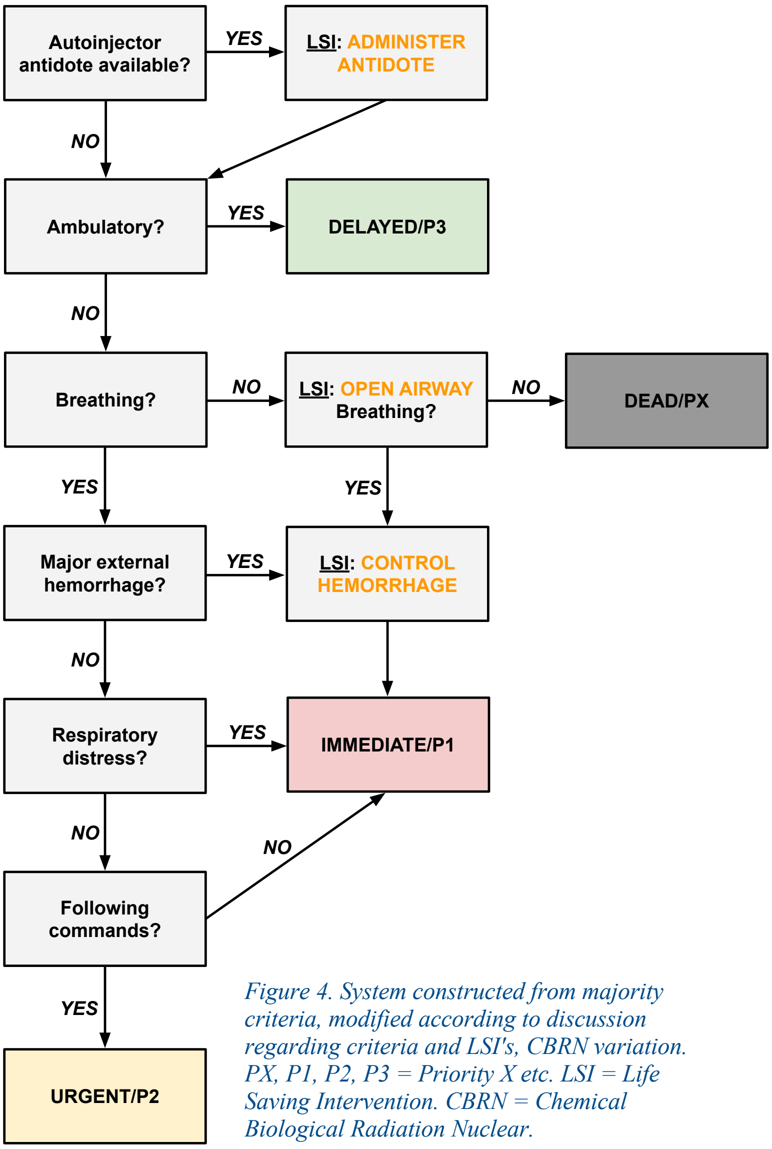


*Figure 4. System constructed from majority criteria, modified according to discussion regarding criteria and LSI's, CBRN variation. PX, P1, P2, P3 = Priority X etc. LSI = Life Saving Intervention. CBRN = Chemical Biological Radiation Nuclear.*

**From here,** further research

can go two ways: one way is a broader search and inclusion of more systems; an extension of the methodology tested in this thesis paper. Another way is to accept the suggested, modified version of the majority criteria system above **(Fig. 3)** since START and modifications thereof are such widespread MCI triage systems today. The proposed system could then be presented to a group of experts according to the Delphi method or it could go through testing in simulations to investigate its performance (speed, precision, fairness, compatibility). As stated above, the suggested system appears to be a viable option and the "selling point" of it being constructed from several, already popular systems could be a strong argument for international implementation.

### Limitations

The basis of the limitations of this study lies in the previously stated fact that it is performed by one single researcher. This echoes throughout the method design, since a lot of seemingly arbitrary choices has been made to produce a tolerable workload for a medical student's thesis paper (approximately 20 weeks of work).

The initial construction of the search term could not be made with the goal of finding *all* mentioned prehospital triage systems for use in MCI's because this would render too many articles to screen for one person. Also, the limiting of articles to solely regard MCI's might have led to missing out on other prehospital triage systems that could also have been applicable in incidents with greater amounts of casualties even if not explicitly stated so.

The PRISMA-workflow was not followed precisely, since the aim of the study was not a systematic review. This meant, in detail, that the process was stopped mid-way (after the first screening) since that was where non-relevant articles had been excluded and frequency of mentions could be analyzed. The screening was made by the author alone, instead of two or more researchers making the selection separately and then comparing their results having a third party to discuss with if disagreements arose. Screening by one person alone might induce bias to select articles containing triage systems of which the names are already known or ones that have more approachable titles and abstracts. Trying to avoid selection bias, the result of the screening was presented to and discussed with senior researchers with experience in science and fieldwork.

The definition of how an article would be pertaining to a system so that it could count as a mention down the line could be viewed as somewhat arbitrary as well. Again, leaving the ultimate decision to the author with the associated risk of bias. Just looking at frequency of mentions meant that no attention was given to the quality of the articles, impact factor etc. However, one has to bear in mind that a large portion of the methodology was chosen just to have *any* scientific way to select and warrant the selection of the systems instead of just picking three, five or ten that came to mind.

Finding the official source of each system in the final group was not possible since tracking down the originators and getting in touch with them would have required too much time and resources. In instances where it was not possible, the system was looked at in numerous articles to see if any differences were found. Several of the systems in the final group have evolved over time and there is a risk that the latest iteration was not found.

Another limitation is connected to the small group of systems selected for the final analysis of overlapping criteria. A majority of the final seven systems stem from the original START system, making for a relatively homogenous group which leads to a very START-like product in the end. If a larger selection of articles could have been made from a broader original search then a larger, more diverse group of systems could have been compared. In this scenario, the overlapping and the final system might have looked different. Also, restricting the rephrasing and overlapping to four tiers (as in excluding ORANGE and GRAY tiers from FDNY-START and SALT) could have contributed to a more uniform end-result. Future research could incorporate any number of tiers to see if there are overlapping criteria in the non-classical categories as well.

## Conclusion

This thesis paper concludes that the studied method of selecting systems, rephrasing criteria, quantifying them and putting together a revised system from the majority criteria is a reasonable approach to the problem of global MCI triage system variability. Applying this model to further, broader research, including a wider array of more heterogenous triage systems has the potential to result in a translational triage system for world-wide use. The final product of this future research could be tested out in simulations and compared to present triage systems in terms of speed, sensitivity and specificity. Deeper studies of current knowledge and evidence-based research of each of the criteria and proposed LSI's is needed together with input from experts in the field.

## Populärvetenskaplig sammanfattning på svenska

# Sorteringssystem för offer vid masskadesituationer: *Kan de mest förekommande systemen översättas till ett?*

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*Sahlgrenska akademin, Göteborg, 2021*

**Triage**, från franskans ”trier” - att sortera, har kommit att bli en grundval inom modern militär och civil medicin. Begreppet härstammar från en kirurg inom Napoleons armé och innebär att *sortera patienter utifrån hur svårt sjuka eller skadade de är* och således efter hur snabb samt hur mycket hjälp de behöver. I moderna triagesystem tas också hänsyn till tillgängliga resurser. Innan införandet av triage lämnades skadade på slagfältet tills det att striden hade bedarrat, de som överlevde till dess fick sedan hjälp utifrån deras rang inom den militära hierarkin.

**Masskadesituationer** (MSS) definieras av WHO som en incident som genererar fler patienter än vad lokalt tillgängliga resurser kan hantera med rutinprocedurer. En MSS kan exempelvis vara en stor trafik- eller industriolycka, naturkatastrof eller ett terrordåd. Eftersom själva definitionen bygger på att tillgängliga resurser inte räcker till blir triage av skadade vid MSS särskilt viktig och i synnerhet den prehospitala triagen. Prehospital triage är den som sker i fält, inför transport, där effektiv och snabb identifiering av vilka som behöver hjälp först eller kanske måste hjälpas på plats blir speciellt betydande.

**Problemet** som examensarbetet tacklar mynnar ur att ett flertal prehospitala triagesystem för MSS finns globalt idag. Systemen är ofta relativt lika varandra i sin utformning men skillnader finns alltid på åtminstone detaljnivå. Att olika länder och regioner inom länder använder olika system utgör en risk då MSS ofta kräver hjälpinsatser bortom lokala resurser.

Ett scenario där hjälpinsatser från olika regioner med olika system arbetar vid samma MSS är fullt tänkbart, speciellt i stora katastroftillbud. Att kategorisera skadade enligt olika kriterier och kategorier utgör ett hot mot den effektivitet och snabbhet som krävs vid MSS.

**Det här examensarbetet** har först tagit fram de sju mest förekommande triagesystemen (enligt specifika kriterier) för MSS i vetenskaplig litteratur publicerad mellan 2000-2020. De sju systemen har sedan använts i en ny metodologi för att kombinera dem till ett. Genom att titta på vilka kriterier varje system kräver för indelning till de olika triagekategorierna samt översätta kriterierna så att de alla talade samma språk och var jämförbara kunde sedan de enskilda kriterierna grupperas efter frekvens. I slutändan kunde ett nytt system skapas utifrån de kriterier som förekom i majoritet.

**Systemet** som skapades med den nya metodologin förfinades sedan i diskussionsdelen vilket också är en del av den metodologi som undersöktes – att testa slutprodukten mot det aktuella forskningsläget och rådande konsensus. I rapporten slås fast att den nya metodologin ter sig fullt gångbar och genererar en rimlig slutprodukt att testa vidare i simulationer eller dyl. Dels kan forskningen gå vidare genom att skala upp projektet och inkludera fler publikationer, system och forskare för att få en potentiellt mer nyanserad slutprodukt. Dels kan det system som föreslås i rapportens diskussionsdel, då detta bygger på erkända system samt diskussion med referenser till relevant forskning, accepteras för vidare testning i simulationer eller för diskussion i expertpaneler (en s.k. Delphistudie).

**Avslutningsvis** slår rapporten fast att de mest förekommande triagesystemen för MSS *kan* kombineras till ett med den nya metodologi som föreslås vilket skulle kunna vara en väg mot global enighet inom området.

## Acknowledges

I would like to thank Associate Prof. Amir Khorram-Manesh for supervision, guidance and his constant availability for correspondence; swiftly answering my questions even during weekends, holidays and late nights. Prof. Eric Carlström has provided valuable feedback and consulting throughout the process. Further, I would like to thank André Jernung at the Biomedical Library of the University of Gothenburg for extensive support during the early stages of the literature search.

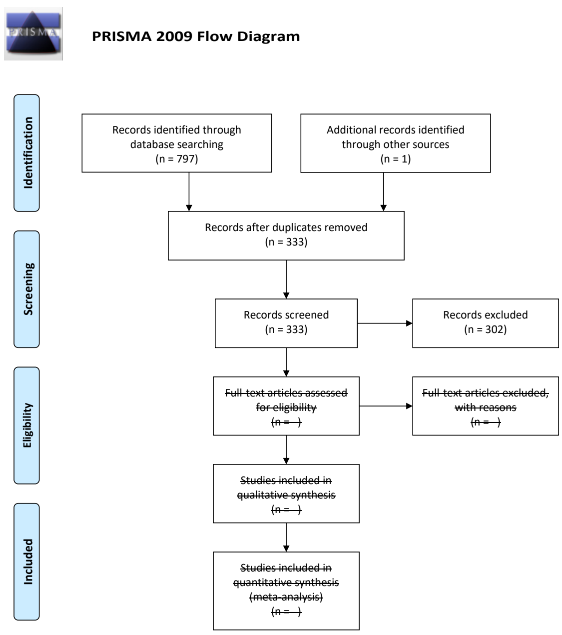
Finally, special thanks are extended to Martin Franzén for tireless discussions regarding stylistic formulations, spelling and grammar.

# Appendixes

## Appx. 1: List of search terms, combinations thereof and number of hits on PubMed

| *Search term* | *Hits* | *Filter* |
|---|---|---|
| (triage) | 20953 | english, 2000-2020 |
| (mass casualty incident) OR (multiple casualty incident) | 2554 | english, 2000-2020 |
| (mass casualty incident) | 2287 | english, 2000-2020 |
| (triage) AND ("emergency medical services") | 2187 | english, 2000-2020 |
| (triage) AND (prehospital) | 1348 | english, 2000-2020 |
| (triage) AND (prehospital) AND (model OR system OR method) | 1234 | english, 2000-2020 |
| ((mass casualty incident) OR (multiple casualty incident)) AND (triage OR prehospital) | 868 | english, 2000-2020 |
| (mass casualty) AND (triage) | 851 | english, 2000-2020 |
| (mass casualty incident) AND (triage OR prehospital) | 805 | english, 2000-2020 |
| (mass casualty incident) OR (multiple casualty incident) AND (triage) | 740 | english, 2000-2020 |
| ((mass casualty incident) OR (multiple casualty incident)) AND (triage OR prehospital) AND (system OR model OR method) | 703 | english, 2000-2020 |
| (mass casualty incident) AND (triage) | 699 | english, 2000-2020 |
| (mass casualty incident) AND ("emergency medical services") | 663 | english, 2000-2020 |
| ((mass casualty incident) OR (multiple casualty incident)) AND (triage) AND (system OR model OR method) | 603 | english, 2000-2020 |
| (multiple casualty incident) | 534 | english, 2000-2020 |
| ((mass casualty incident) OR (multiple casualty incident)) AND (triage) AND ("emergency medical services") | 266 | english, 2000-2020 |
| ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) | 232 | english, 2000-2020 |
| (mass casualty incident) AND (prehospital) | 202 | english, 2000-2020 |
| ((mass casualty incident) OR (multiple casualty incident)) AND (triage) AND (prehospital) | 104 | english, 2000-2020 |
| ((mass casualty incident) OR (multiple casualty incident)) AND (triage) AND (prehospital OR pre-hospital) | 104 | english, 2000-2020 |
| (mass casualty incident) AND (triage) AND (prehospital) | 96 | english, 2000-2020 |
| (mass casualty incident) AND (triage) AND (model OR system) AND (prehospital) | 57 | english, 2000-2020 |

## Appx. 2: Official PRISMA 2009 Flow Diagram




*From:* Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

**For more information, visit www.prisma-statement.org.**

## Appx. 3: Searches and hits for hospital triage system proposed by external professor

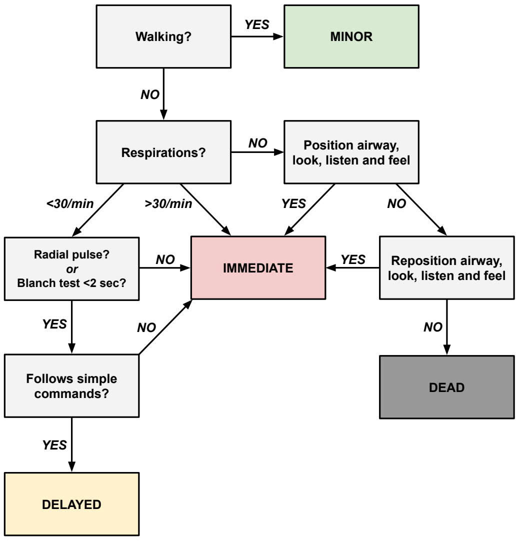
| System | Hits | Y/N | Motivation | Search term |
|---|---|---|---|---|
| **Canadian Triage and Acuity Scale (CTAS)** | 0 | N | No hits. | ("Canadian Triage and Acuity Scale" OR "CTAS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Emergency Severity Index (ESI)** | 0 | N | No hits. | ("Emergency Severity Index" OR "ESI") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Japanese Triage and Acuity Scale (JTAS)** | 0 | N | No hits. | ("Japanese Triage and Acuity Scale" OR "JTAS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Medical Emergency Triage and Treatment System (METTS)** | 31 | N | None of the titles or abstracts indicated use of METTS as a prehospital triage system for MCI's. | ("Medical Emergency Triage and Treatment System" OR "METTS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Modified Early Warning Score (MEWS)** | 0 | N | No hits. | ("Modified Early Warning Score" OR "MEWS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Manchester Triage System (MTS)** | 0 | N | No hits. | ("Manchester Triage System" OR "MTS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **PMH A&E Triage Scale (PATS)** | 0 | N | No hits. | ("PMH A&E Triage Scale" OR "PATS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Rapid Emergency Triage and Treatment System (RETTS)** | 0 | N | No hits. | ("Rapid Emergency Triage and Treatment System" OR "RETTS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Rapid triage score (RTS)** | 5 | N | None of the titles or abstracts indicated use of RTS as a prehospital triage system for MCI's. | ("Rapid triage score" OR "RTS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **South African Triage Score (SATS)** | 0 | N | No hits. | ("South African Triage Score" OR "SATS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Taiwan Triage and Acuity Scale (TTAS)** | 2 | N | None of the titles or abstracts indicated use of TTAS as a prehospital triage system for MCI's. | ("Taiwan Triage and Acuity Scale" OR "TTAS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |
| **Taiwan Triage System (TTS)** | 1 | N | The title or abstract did not indicate use of TTS as a prehospital triage system for MCI's. | ("Taiwan Triage System" OR "TTS") AND ((mass casualty incident) OR (multiple casualty incident)) AND (prehospital) |

## Appx. 4: Final list of articles with titles and PMID's. Frequency of mentioned triage systems

| PMID | Title | Frequency: | _START | _META | _SALT | _PRIOR | _mSTART | _FTS | _ASAV | _CFT | _TS | _MPTT | _FDNY | _STM | _mMS | _MS | _ATLS | _GCS | _CBRN | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30033695 | Comparison of the Simple Triage and Rapid Treatment system versus the Prehospital Advanced Triage Model in multiple-casualty events | | 1 | 1 | | | | | | | | | | | | | | | | |
| 30241022 | Comparative study of a simulated incident with multiple victims and immersive virtual reality | | 1 | | | | | | | | | | | | | | | | | |
| 31389327 | Triage Performance of School Personnel Using the SALT System | | | | 1 | | | | | | | | | | | | | | | |
| 30129913 | Intuitive versus Algorithmic Triage | | 1 | | | | | | | | | | | | | | | | | |
| 17894217 | Field triage and patient maldistribution in a mass-casualty incident | | 1 | | | | | | | | | | | | | | | | | |
| 29661267 | Comparison of Electronic Versus Manual Mass-Casualty Incident Triage | | 1 | | | | | | | | | | | | | | | | | |
| 28822212 | Comparison of START and SALT triage methodologies to reference standard definitions and to a field mass casualty simulation | | 1 | | 1 | | | | | | | | | | | | | | | |
| 16998387 | Triage accuracy at a multiple casualty incident disaster drill: the Emergency Medical Service, Fire Department of New York City experience | | 1 | | | | | | | | | | | | | | | | | |
| 28798972 | Diagnostic precision of triage algorithms for mass casualty incidents. English version | | 1 | | | 1 | 1 | 1 | 1 | 1 | 1 | | | | | | | | | |
| 27130042 | The development and features of the Spanish prehospital advanced triage method (META) for mass casualty incidents | | | 1 | | | | | | | | | | | | | | | | |
| 26857296 | First Responder Accuracy Using SALT during Mass-casualty Incident Simulation | | | | 1 | | | | | | | | | | | | | | | |
| 29270957 | Presence of undertriage and overtriage in simple triage and rapid treatment | | 1 | | | | | | | | | | | | | | | | | |
| 28065200 | Testing the START Triage Protocol: Can It Improve the Ability of Nonmedical Personnel to Better Triage Patients During Disasters and Mass Casualties Incidents ? | | 1 | | | | | | | | | | | | | | | | | |
| 20586018 | Triage performance of first-year medical students using a multiple-casualty scenario, paper exercise | | 1 | | | | | | | | | | | | | | | | | |
| 26102041 | Comparison of START triage categories to emergency department triage levels to determine need for urgent care and to predict hospitalization | | 1 | | | | | | | | | | | | | | | | | |
| 28131484 | Major incident triage: Derivation and comparative analysis of the Modified Physiological Triage Tool (MPTT) | | | | | | | | | 1 | 1 | 1 | | | 1 | 1 | | | | |
| 25687598 | A modified simple triage and rapid treatment algorithm from the New York City (USA) Fire Department | | | | | | | | | | | | 1 | | | | | | | |
| 18491654 | Mass-casualty triage: time for an evidence-based approach | | 1 | | | | | | | 1 | 1 | | | 1 | | | | | | |
| 24355021 | Triage performance of Swedish physicians using the ATLS algorithm in a simulated mass casualty incident: a prospective cross-sectional survey | | | | | | | | | | | | | | | | 1 | | | |
| 19731169 | Pilot test of the SALT mass casualty triage system | | | | 1 | | | | | | | | | | | | | | | |
| 25214310 | Evaluation of a novel algorithm for primary mass casualty triage by paramedics in a physician manned EMS system: a dummy based trial | | | | | | | | 1 | | | | | | | | | | | |
| 26451778 | First Responder Accuracy Using SALT after Brief Initial Training | | | | 1 | | | | | | | | | | | | | | | |
| 27964769 | Paramedic Application of a Triage Sieve: A Paper-Based Exercise | | | | | | | | | | 1 | | | | | | | | | |
| 28971847 | The civilian validation of the Modified Physiological Triage Tool (MPTT): an evidence-based approach to primary major incident triage | | | | | | | | | | | 1 | | | | | | | | |
| 21591923 | Paramedic accuracy using SALT triage after a brief initial training | | | | 1 | | | | | | | | | | | | | | | |
| 11339732 | A two-hour intervention using START improves prehospital triage of mass casualty incidents | | 1 | | | | | | | | | | | | | | | | | |
| 26553510 | Comparison of the Sacco Triage Method Versus START Triage Using a Virtual Reality Scenario in Advance Care Paramedic Students | | 1 | | | | | | | | | | | 1 | | | | | | |
| 23465555 | Head-to-Head Comparison of Disaster Triage Methods in Pediatric, Adult, and Geriatric Patients | | 1 | | | | | | | 1 | | | 1 | 1 | | | | 1 | | |
| 18769263 | Mass Casualty Triage: An Evaluation of the Data and Development of a Proposed National Guideline | | | | 1 | | | | | | | | | | | | | | | |
| 18379923 | Pilot test of a proposed chemical/biological/radiation/nuclear-capable mass casualty triage system | | | | | | | | | | | | | | | | | | 1 | |
| 19947863 | Use of SALT triage in a simulated mass-casualty incident | | | | 1 | | | | | | | | | | | | | | | |
| | | | _START | _META | _SALT | _PRIOR | _mSTART | _FTS | _ASAV | _CFT | _TS | _MPTT | _FDNY | _STM | _mMS | _MS | _ATLS | _GCS | _CBRN | SUM |
| | | | 16 | 2 | 8 | 1 | 1 | 1 | 2 | 4 | 4 | 2 | 2 | 3 | 1 | 1 | 1 | 1 | 1 | 51 |

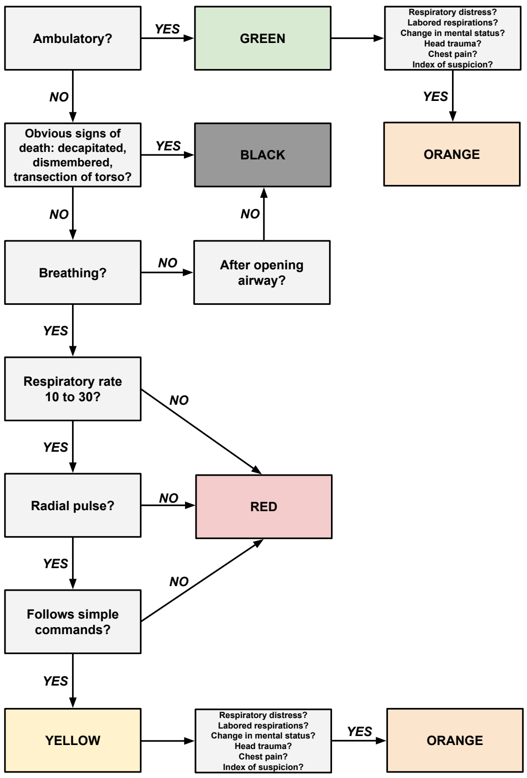
**Appx. 5**: **The final seven triage systems and sources**

### Simple Triage and Rapid Transport (START) and Modified START (mSTART)



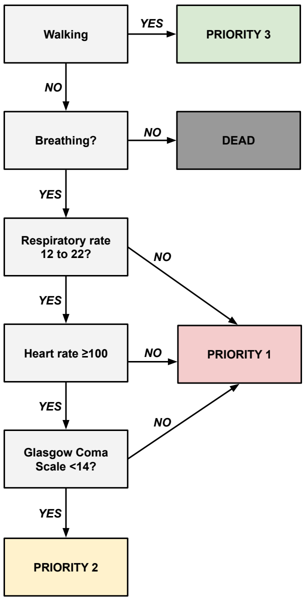

*Source: Community Emergency Response Team Unit, L. A. F. D. H. S. D. Simple Triage and Rapid Treatment (START), <https://www.cert-la.com/cert-training-education/start/> (2020)*

### Fire Department of New York modified START (FDNY-START)



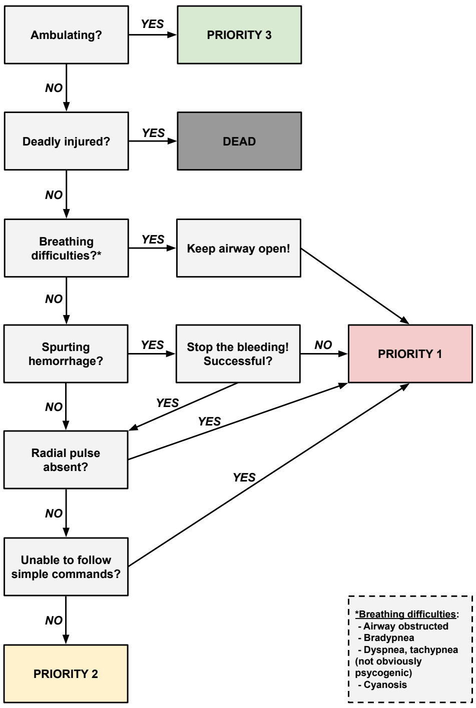

*Source: Arshad, F. H. et al. A modified simple triage and rapid treatment algorithm from the New York City (USA) Fire Department. Prehosp Disaster Med 30, 199-204, doi:10.1017/S1049023X14001447 (2015)*

## Modified Physiological Triage Tool (MPTT)



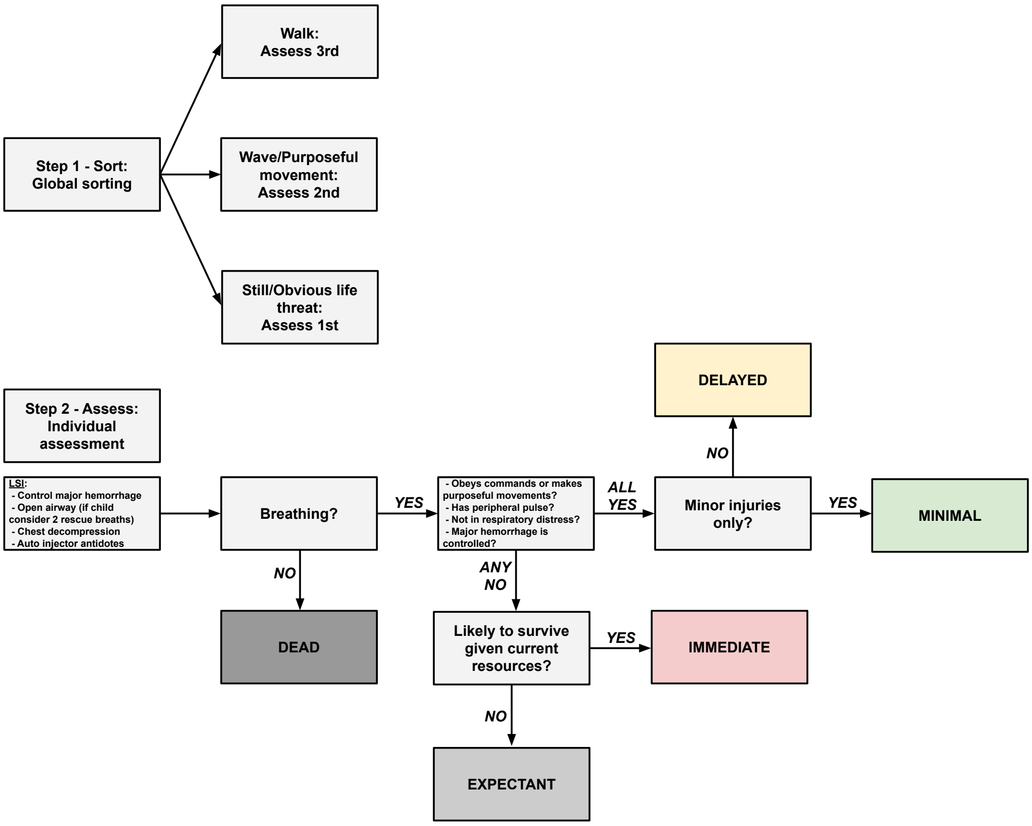

*Source: Vassallo, J., Beavis, J., Smith, J. E. & Wallis, L. A. Major incident triage: Derivation and comparative analysis of the Modified Physiological Triage Tool (MPTT). Injury 48, 992-999, doi:10.1016/j.injury.2017.01.038 (2017)*

## Amberg-Schwandorf Algorithm for Primary Triage (ASAV)



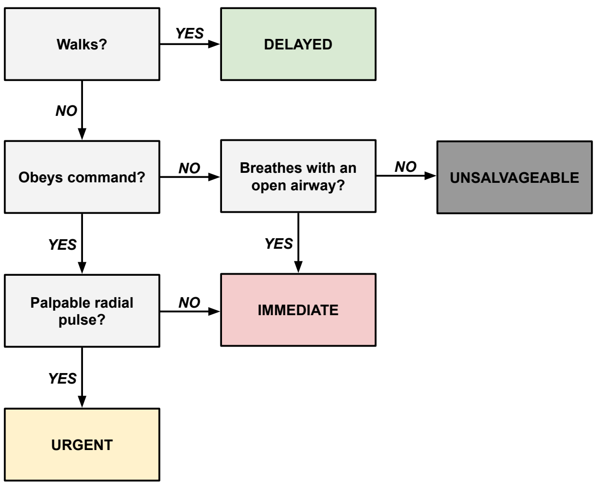

*Source: Wolf, P., Bigalke, M., Graf, B. M., Birkholz, T. & Dittmar, M. S. Evaluation of a novel algorithm for primary mass casualty triage by paramedics in a physician manned EMS*

## Sort, Assess, Lifesaving Intervention, Triage/Transport (SALT)



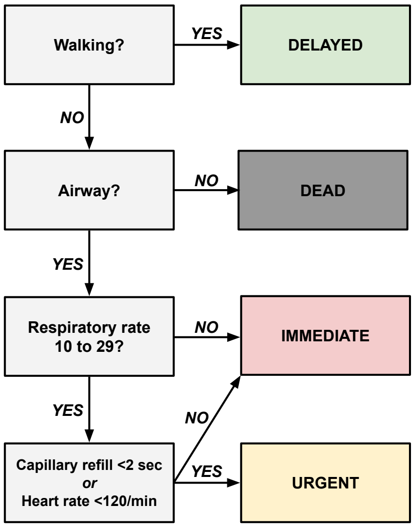

*Source: Lerner, E. B. et al. Mass casualty triage: an evaluation of the science and refinement of a national guideline. Disaster Med Public Health Prep 5, 129-137, doi:10.1001/dmp.2011.39 (2011)*

## CareFlight Triage (CFT)




*Source: Garner, A., Lee, A., Harrison, K. & Schultz, C. H. Comparative analysis of multiple-casualty incident triage algorithms. Ann Emerg Med 38, 541-548, doi:10.1067/mem.2001.119053 (2001)*

## Triage Sieve (TS)




*Source: Garner, A., Lee, A., Harrison, K. & Schultz, C. H. Comparative analysis of multiple-casualty incident triage algorithms. Ann Emerg Med 38, 541-548, doi:10.1067/mem.2001.119053 (2001)*

## Appx. 6: Original phrasing, rephrasing and merging of criteria from the final seven systems

| System, Source | Tier | Original phrase | Rephrasing | Merging with/final form |
|---|---|---|---|---|
| **START/ mSTART**<br>*Community Emergency Response Team Unit, L. A. F. D. H. S. D. Simple Triage and Rapid Treatment (START), <https://www.cert-la.com/cert-training-education/start/> (2020).* | **DEAD** | Non-walking | Non-ambulatory | Non-ambulatory |
| | | Respiration: NO<br>_After positioning and repositioning of airway: NO | Not breathing after 2 attempts of positioning airway | Not breathing<br>_after 1-2 attempts of positioning airway |
| | **IMMEDIATE** | Non-walking | Non-ambulatory | Non-ambulatory |
| | | Respiration: NO<br>_After positioning of airway: YES/NO<br>_After respositioning of airway: YES | Breathing only after positioning of airway (1 or 2 tries) | Breathing/open airway<br>_only after positioning |
| | | Respiration: YES<br>_Over 30/min | RR >30/min | RR<br>_>30/min |
| | | Radial pulse: Absent (mSTART) | Radial pulse absent | Radial/peripheral pulse absent |
| | | Blanch test: Over 2/sec (START) | CF >2 sec | CF >2 sec |
| | | Mental status: Can't follow simple commands | Unable to follow commands | Following commands/neurological status<br>_unable |
| | **DELAYED** | Non-walking | Non-ambulatory | Non-ambulatory and not [black (PX)] or [red (P1)] |
| | | Respiration: YES<br>_Under 30/min | Not fulfilling any [black] or [red] criteria | |
| | | Radial pulse: Present (mSTART) | | |
| | | Blanch test: Under 2/sec (START) | | |
| | | Mental status: Follows simple commands | | |
| | **MINOR** | Walking wounded and uninjured | Ambulatory | Ambulatory |
| **FDNY-START**<br>*Arshad, F. H. et al. A modified simple triage and rapid treatment algorithm from the New York City (USA) Fire Department. Prehosp Disaster Med 30, 199-204, doi:10.1017 /S1049023X14001447 (2015).* | **BLACK** | Non-ambulatory | Non-ambulatory | Non-ambulatory |
| | | Obvious signs of Death: Decapitated, Dismembered, Transection of Torso | Obvious signs of death (defined) | Obvious signs of death |
| | | Breathing: No, even after opening airway | Not breathing after 1 attempt at positioning airway | Not breathing<br>_after 1-2 attempts of positioning airway |
| | **RED** | Non-ambulatory | Non-ambulatory | Non-ambulatory |
| | | Breathing: YES | Breathing | Breathing/open airway |
| | | Respirations rate 10 to 30: NO | RR>30/min or RR<10/min | RR<br>_>30/min or <10/min |
| | | Radial pulse: NO | Radial pulse absent | Radial/peripheral pulse absent |
| | | Follows commands: NO | Unable to follow commands | Following commands/neurological status<br>_unable |
| | **YELLOW** | Non-ambulatory | Non-ambulatory | Non-ambulatory and not [black (PX)] or [red (P1)] |
| | | Respirations rate 10 to 30: YES | Not fulfilling any [black] or [red] criteria | |
| | | Radial pulse: YES | | |
| | | Follows commands: YES | | |
| | **GREEN** | Ambulatory | Ambulatory | Ambulatory |
| | **ORANGE** | GREEN or YELLOW casualty who subsequently is found to have:<br>- Respiratory Distress<br>- Labored Respirations<br>- Change in Mental Status<br>- Head Trauma<br>- Chest Pain<br>- Index of Suspicion? | GREEN or YELLOW casualty who subsequently is found to have:<br>- Respiratory Distress<br>- Labored Respirations<br>- Change in Mental Status<br>- Head Trauma<br>- Chest Pain<br>- Index of Suspicion? | GREEN or YELLOW casualty who subsequently is found to have:<br>- Respiratory Distress<br>- Labored Respirations<br>- Change in Mental Status<br>- Head Trauma<br>- Chest Pain<br>- Index of Suspicion? |
| **MPTT**<br>*Vassallo, J., Beavis, J., Smith, J. E. & Wallis, L. A. Major incident triage: Derivation and comparative analysis of the Modified Physiological Triage Tool (MPTT). Injury 48, 992-999, doi: 10.1016/j.injury.2017.01.038 (2017).* | **DEAD** | Walking: NO | Non-ambulatory | Non-ambulatory |
| | | Breathing: NO | Not breathing | Not breathing |
| | **PRIORITY 1** | Walking: NO | Non-ambulatory | Non-ambulatory |
| | | Breathing: YES | Breathing | Breathing/open airway |
| | | Respiratory Rate: <12 or ≥22 | RR≥22/min or RR<12/min | RR<br>_≥22/min or <12/min |
| | | Heart Rate: ≥100 | HR ≥100/min | HR<br>_≥100/min |
| | | Glascow Coma Scale <14: YES | GCS <14 | Following commands/neurological status<br>_GCS <14 |
| | **PRIORITY 2** | Walking: NO | Non-ambulatory | Non-ambulatory and not [black (PX)] or [red (P1)] |
| | | Respiratory Rate: ≥12 and <22 | Not fulfilling any [black] or [red] criteria | |
| | | Heart Rate: <100 | | |
| | | Glascow Coma Scale <14: NO | | |
| | **PRIORITY 3** | Walking: YES | Ambulatory | Ambulatory |
| **ASAV**<br>*Wolf, P., Bigalke, M., Graf, B. M., Birkholz, T. & Dittmar, M. S. Evaluation of a novel algorithm for primary mass casualty triage by paramedics in a physician manned EMS system: a dummy based trial. Scand J Trauma Resusc Emerg Med 22, 50, doi:10.1186/s13049-014-0050-6 (2014).* | **DEAD** | Ambulating: NO | Non-ambulatory | Non-ambulatory |
| | | Deadly injured: YES | Deadly injured | Obvious signs of death |
| | **PRIORITY 1** | Ambulating: NO | Non-ambulatory | Non-ambulatory |
| | | Deadly injured: NO | Not deadly injured | Not deadly injured |
| | | Breathing difficulties: YES (Keep airway open!)<br>(Definition:<br>- Airway obstructed<br>- Bradypnoea, apnoea<br>- Dyspnoea, tachypnoea (not obviously psychogenic)<br>- Cyanosis) | Breathing difficulties (defined) | Respiratory distress |
| | | Spurting hemmorhage: YES<br>_Stop the bleeding! Successful: NO | Spurting hemmorhage persistent after attempt to control | Major hemmorhage persistent after attempt to control |
| | | Radial pulse absent: Pulse absent | Radial pulse absent | Radial/peripheral pulse absent |
| | | Unable to follow simple commands: Unable | Unable to follow commands | Following commands/neurological status<br>_unable |
| | **PRIORITY 2** | Ambulating: NO | Non-ambulatory | Non-ambulatory and not [black (PX)] or [red (P1)] |
| | | Deadly injured: NO | Not fulfilling any [black] or [red] criteria | |
| | | Breathing difficulties: NO | | |
| | | Spurting hemmorhage: YES/NO<br>_Stop the bleeding! Successful: YES | | |
| | | Radial pulse absent: palpable | | |
| | | Unable to follow simple commands: Follows commands | | |
| | **PRIORITY 3** | Ambulating: YES | Ambulatory | Ambulatory |
| **SALT**<br>*Lerner, E. B. et al. Mass casualty triage: an evaluation of the science and refinement of a national guideline. Disaster Med Public Health Prep 5, 129-137, doi:10.1001 /dmp.2011.39 (2011).* | **DEAD** | (After performing LSI if needed) | | |
| | | Breathing: NO | Not breathing after:<br>- Positioning of airway and/or;<br>- Chest decompression | Not breathing<br>_after 1-2 attempts at positioning airway<br>_after chest decompression |
| | **IMMEDIATE** | Likely to survive given current resources: YES | Likely to survive given current resources | Likely to survive given current resources |
| | | Breathing: YES | Breathing | Breathing/open airway |
| | | Obeys commands or makes purposeful movements: NO | Not following commands or making purposeful movements | Following commands/neurological status<br>_unable<br>__...or not making purposeful movements |
| | | Has peripheral pulse: NO | Peripheral pulse absent | Radial/peripheral pulse absent |
| | | Not in respiratory distress: NO | In respiratory distress | Respiratory distress |
| | | Major hemmorhage is controlled: NO | Major hemorrhage persistent after attempt to control | Major hemorrhage persistent after attempt to control |
| | **DELAYED** | Breathing: YES | Not fulfilling any [black (PX)] or [red (P1)] criteria | Not fulfilling any [black (PX)] or [red (P1)] criteria |
| | | Obeys commands or makes purposeful movements: YES | | |
| | | Has peripheral pulse: YES | | |
| | | Not in respiratory distress: YES | | |
| | | Major hemmorhage is controlled: YES | | |
| | | Minor injuries only: NO | More than minor injuries | More than minor injuries |
| | **MINOR** | Breathing: YES | Not fulfilling any [black] or [red] criteria | Not fulfilling any [black] or [red] criteria |
| | | Obeys commands or makes purposeful movements: YES | | |
| | | Has peripheral pulse: YES | | |
| | | Not in respiratory distress: YES | | |
| | | Major hemmorhage is controlled: YES | | |
| | | Minor injuries only: YES | Only minor injuries | Only minor injuries |
| | **EXPECTANT** | Likely to survive given current resources: NO | EXPECTANT/GRAY<br>- Not following commands or make purposeful movements and/or;<br>- Peripheral pulse absent and/or;<br>- In respiratory distress and/or;<br>- Major hemorrhage persistent after attempt to control<br>*...and **not likely to survive given current resources*** | EXPECTANT/GRAY<br>- Not following commands or make purposeful movements and/or;<br>- Peripheral pulse absent and/or;<br>- In respiratory distress and/or;<br>- Major hemorrhage persistent after attempt to control<br>*...and **not likely to survive given current resources*** |
| | | Breathing: YES | | |
| | | Obeys commands or makes purposeful movements: NO | | |
| | | Has peripheral pulse: NO | | |
| | | Not in respiratory distress: NO | | |
| | | Major hemmorhage is controlled: NO | | |
| **CFT**<br>*Garner, A., Lee, A., Harrison, K. & Schultz, C. H. Comparative analysis of multiple-casualty incident triage algorithms. Ann Emerg Med 38, 541-548, doi:10.1067/mem.2001.119053 (2001).* | **UNSALVAGEABLE** | Walks: NO | Non-ambulatory | Non-ambulatory |
| | | Obeys command: NO | Not following commands | Following commands/neurological status<br>_unable |
| | | Breathes with open airway: NO | Not breathing with an open airway | Not breathing |
| | **IMMEDIATE** | Walks: NO | Non-ambulatory | Non-ambulatory |
| | | Obeys command: NO | Not following commands | Following commands/neurological status<br>_unable |
| | | Breathes with open airway: YES | Breathing with an open airway | Breathing/open airway |
| | | Palpable radial pulse: NO | No palpable radial pulse | Radial/peripheral pulse absent |
| | **URGENT** | Walks: NO | Non-ambulatory | Non-ambulatory and not [black (PX)] or [red (P1)] |
| | | Obeys command: YES | Not fulfilling any [black] or [red] criteria | |
| | | Palpable radial pulse: YES | | |
| | **DELAYED** | Walks: YES | Ambulatory | Ambulatory |
| **TS**<br>*Garner, A., Lee, A., Harrison, K. & Schultz, C. H. Comparative analysis of multiple-casualty incident triage algorithms. Ann Emerg Med 38, 541-548, doi:10.1067/mem.2001.119053 (2001).* | **DEAD** | Walking: NO | Non-ambulatory | Non-ambulatory |
| | | Airway: NO | Airway not open | Not breathing |
| | **IMMEDIATE** | Walking: NO | Non-ambulatory | Non-ambulatory |
| | | Airway: YES | Open airway | Breathing/open airway |
| | | Respiratory rate: Below 10 or over 29 | RR>29/min or RR<10/min | RR<br>_>29/min or <10/min |
| | | Capillary refill: Over 2s | CF >2 sec | CF >2 sec |
| | | Heart rate: Over 120/min | HR >120/min | HR<br>_>120/min |
| | **URGENT** | Walking: NO | Non-ambulatory | Non-ambulatory and not [black (PX)] or [red (P1)] |
| | | Airway: YES | Not fulfilling any [black] or [red] criteria | |
| | | Respiratory rate: 10-29 | | |
| | | Capillary refill: Under 2s | | |
| | | Heart rate: Under 120/min | | |
| | **DELAYED** | Walking: YES | Ambulatory | Ambulatory |

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