Review

Adult Triage in the Emergency Department. Introducing a Multi-Layer Triage System

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Posted Date: 31 March 2025

doi: 10.20944/preprints202503.2273.v1

Keywords: Triage; Early Warning Scores; ESI; NEWS; HEART; Emergency Department

 doi:10.20944/preprints202503.2273.v1

Review

Adult Triage in the Emergency Department. Introducing a Multi-Layer Triage System

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Abstract: Emergency Department (ED) Triage is the cornerstone of ED operations. Many different triage systems have been proposed and implemented globally. To date an ideal triage system has not been identified. As the burden on ED's rises with overcrowding being recognized as a universal problem ED triage needs to restructure to address this reality. Extensive and critical of the literature has identified the strengths and weaknesses of current ED triage implementations. A novel multi-layer triage system was introduced and implemented in Greek ED's combining the strengths of various triage and Early Warning Systems and scores, in an effort to minimize under-triage and the adverse downstream effects that in creates on patient outcomes. In its years of implementation, it has proven to be fast, accurate, objective, and reproducible. Acknowledging that no triage system can be universally adapted in different settings, that the structural concepts of this triage system address most of the triage problems currently reported in the literature.

Keywords: Triage; Early Warning Scores; ESI; NEWS; HEART; Emergency Department

1. Introduction

Emergency department (ED) overcrowding is a global phenomenon that delays diagnostic and therapeutic interventions [8]. This time delay might crucially affect patient outcomes [1]. As ED patient volumes increase, and even more people endure constantly prolonging waiting times an accurate triage system becomes vital.

Hospital Triage is a process through which healthcare professionals actively try to identify high-acuity patients and prioritize them accordingly. These patients range from critically ill in need of immediate life-saving interventions to patients with minor medical problems and low urgency. The majority of the ED population lie in between these two extremes. Both over-triage and under-triage have a negative impact on ED flow and patient waiting times. Under-triage might leave a critical patient in the waiting room for a prolonged period of time leading to severe deterioration. Over-triage will foverflow the treatment area with lower acuity patients consuming all available treatment places and resources and thus preventing higher acuity patients from entering timely and prolonging their time in the waiting area.

Each healthcare system and even each Emergency Department has developed a triage system most fitting to their specific needs. Whatever triage system is chosen, it must meet the following requirements: it must be useful, valid and reproducible. It must also be easy to use and classify, to help medical staff determine the level of triage in the shortest possible time [7,8].

The Emergency Department of Nikaia General Hospital, Nikaia, Greece is the busiest ED in Greece with more than 1000 ED visits in a 24-hour shift. The Emergency department of Larisa General Hospital, Greece has more than 300 ED-visits in a 24-hour shift. This overflow of incomings combined with other structural vulnerabilities of the Greek emergency health care system lead to prolonged waiting times from triage to physician with right to treat, that in some cases may exceed 6 hours. In 2018 we restructured our adult patient triage protocols, introducing a multi-layer triage approach

 doi:10.20944/preprints202503.2273.v1

based on the Swiss cheese model[34] (Figure 1). Our goal was to combine the strengths of accredited triage and early warning systems and scores to produce a process that would ensure that prolonged waiting times would not have a negative impact on patient outcomes [33].

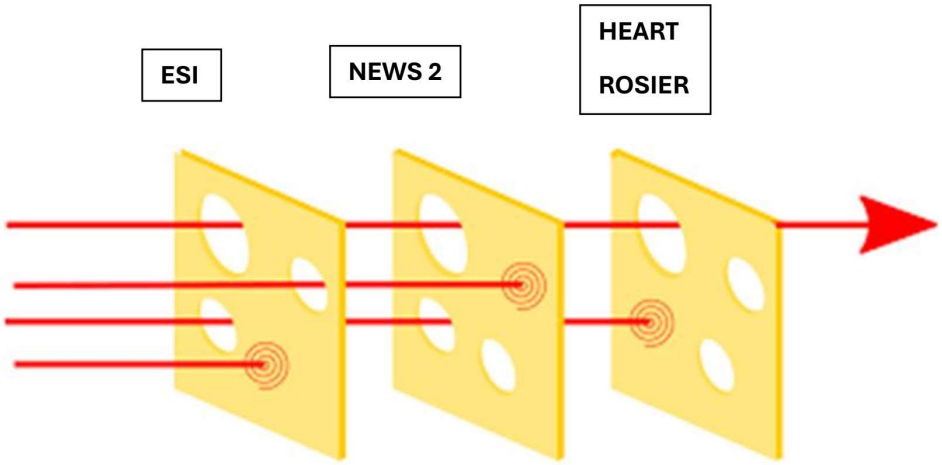

Figure 1. The multi-layer triage approach. (Based on Ben Aveling cheese model[35].)(ESI , Emergency Severity Index; NEWS 2, National Early Warning Score 2).

Based on these principles, the Hellenic Society for Emergency Medicine developed in 2024 a National Triage Proposal [11].

2. Evaluating Existing Scoring Systems

Existing scoring systems can be roughly divided into three main categories.

a. Symptom Based Triage Systems—Clinical Impression Triage Systems

The most widely used triage systems in this category are the Manchester Triage system (MTS), the Australasian triage system (ATS), the Emergency Severity Index (ESI) and the Canadian Triage and Acuity Scale (CTAS). These 5-tier scoring systems, are all well validated and widely adopted in ED's globally.

The outlines of each triage system are presented in Table 1.

Table 1. Characteristics of the most important five-level triage systems.

Parameter	ATS	MTS	CTAS	ESI
Time to initial assessment	10 min	ns	ns	ns
Time to contact with doctor with right to treat	Immediate / 10 / 30 /60 / 120 min	Immediate / 10 / 60 /120 / 240 min	Immediate / 15 / 30 /60 / 120 min	Immediate / 10 min /n. s
Re-triage	ns	As required	I:continuously; II: 15 min; III: 30 min; IV: 60 min; V: 120 min	As required
List of diagnoses or key symptoms	YES	52 Key Symptoms	YES	No
Training material	YES	YES	YES	YES

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ATS, Australasian Triage Scale (previously National Triage Scale, NTS); CTAS, Canadian Triage and Acuity Scale; MTS, Manchester Triage Scale; ESI, Emergency Severity Index; n. s., not specified; I to V: triage priority levels.

There is still no clear advantage of one triage system over another [8,10,12].

Triage accuracy by all the above systems ranges between 56% and 87% [2]. All define very precisely and concordantly the highest (1 and 2) and the lowest (5) priorities, while assigning priorities to the intermediate categories (3 and 4) was less precise for adult population [8]. ESI has been reported to have a 20%-30% under-tirage rate even for high acuity patients [4,6,9,13,14]. In our setting when using ESI alone accuracy was calculated at 63%, with an overall 23,6% under-triage rate [3]. Interpretation of vital sign deterioration has been identified as one of the factors leading to under-triage when using the ESI [5].

Summarizing the strengths of symptom-based triage systems are validated, fast, simple and reliable for higher acuity patients (Priority 1 and Priority 2) and very low acuity patients (Priority 5). Their weaknesses include a high percentage of under-triage even for high acuity patients. They remain mainly subjective (depending on the level of training of the triage personnel) and thus not reproducible.

We chose to implement the ESI triage system mainly because there are no preset response times for each triage category and it fit better with our practice and policies so far. By choosing ESI almost 80% of our high acuity patients and our very low acuity patients should be identified quickly and accurately. A second triage layer would be needed to find these under-triaged critically ill patients and sort out medium and low acuity patients. Since ESI is not symptom based, we added a number of critical presenting symptom clusters from MTS, ATS and CTAS as “Red Flag” symptoms to be recognized and prioritized accordingly.

b. Early Warning Scores (EWS)

Early warning scores are based on the concept that altered physiology often precedes patient deterioration and death. Derangements in simple physiological observations (vital signs) can identify patients at high risk of deterioration. By recording and grading multiple parameters simultaneously, subtle changes in vital signs can be used to initiate early emergency management [16,17]. Most widespread are the Rapid Acute Physiology Score (RAPS), Modified EWS (MEWS), Modified EWS with Glascow Coma Scale (GCS) (MEWS GCS), Rapid Emergency Medicine Score (REMS), Goodacre Score, Worthing Physiological Score (WPS), Groarke Score, VitalPac EWS (ViEWS), Abbreviated VitalPac EWS (AbViEWS), Glasgow Coma Scale-Age-Systolic Blood Pressure Score, Vital Sign Score (VSS), National EWS (NEWS) and Vital Sign Group (VSG) Scores.

Early warning scores can accurately predict outcomes in a number of different populations [18,21]. They have been found to be excellent predictors of cardiac arrest, ICU transfer and death on ICU, mortality within 2-days, deterioration within 2-days, and hospital admissions [18,19]. Among their advantages are accuracy, cross specialty application, impact on communication and opportunity for automation[19]. Their weak points are Sensitivity, especially compared to specialty-specific scores, Need for practitioner engagement, and need for clinical judgment.

EWS have been proposed as Emergency Department Triage tools[21]. EWS Triage outperforms symptom-based triage in high acuity patient recognition and risk stratification of mid acuity patients [20].

As there is no clear advantage to one EWS system over another [18] we have chosen to integrate NEWS 2 into our multi-layer triage system. NEWS 2 is simple, easy to use and reproducible. The vital signs are recorded on the table chart and the score is calculated (Figure 2). Once the NEWS 2 score is calculated appropriate response triggers are provided by the Royal College of Physicians (Figure 3)[22,23].

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Physiological parameter	Score 3	2	1	0	1	2	3
Respiration rate (per minute)	≤8		9–11	12–20		21–24	≥25
SpO_2 Scale 1 (%)	≤91	92–93	94–95	≥96			
SpO_2 Scale 2 (%)	≤83	84–85	86–87	88–92 ≥93 on air	93–94 on oxygen	95–96 on oxygen	≥97 on oxygen
Air or oxygen?		Oxygen		Air			
Systolic blood pressure (mmHg)	≤90	91–100	101–110	111–219			≥220
Pulse (per minute)	≤40		41–50	51–90	91–110	111–130	≥131
Consciousness				Alert			CVPU
Temperature (°C)	≤35.0		35.1–36.0	36.1–38.0	38.1–39.0	≥39.1	

Figure 2. NEWS 2 chart. (Royal College of Physicians. National Early Warning Score (NEWS) 2: Standardising the assessment of acute-illness severity in the NHS. Updated report of a working party. London: RCP, 2017.).

NEW score	Clinical risk	Response
Aggregate score 0–4	Low	Ward-based response
Red score Score of 3 in any individual parameter	Low–medium	Urgent ward-based response*
Aggregate score 5–6	Medium	Key threshold for urgent response*
Aggregate score 7 or more	High	Urgent or emergency response**

* Response by a clinician or team with competence in the assessment and treatment of acutely ill patients and in recognising when the escalation of care to a critical care team is appropriate.

**The response team must also include staff with critical care skills, including airway management.

Figure 3. NEWS 2 thresholds and triggers. (Royal College of Physicians. National Early Warning Score (NEWS) 2: Standardising the assess-ment of acute-illness severity in the NHS. Updated report of a working party. London: RCP, 2017.).

Summarizing. NEWS 2 is a validated and easy to use score[24]. By choosing to add NEWS 2 as a second layer in our triage process, we address vital signs interpretation that was one of the most common error points in the triage systems mentioned above. We decrease the probability of under-triaging high acuity patients as NEWS 2 has a better sensitivity in detecting high acuity patients that have been under triaged in the previous step. By using the integrated thresholds and triggers, patients can subjectively and reproducibly be further triaged as middle and low acuity. Adding this layer slightly prolongs the triage process. This time delay will have a minimal impact in patient outcomes as the Priority 1 and Priority 2 patients that need immediate treatment have already been transferred to the treatment area by using ESI.

c. Specific Disease Scores

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Time sensitive, high mortality conditions might have atypical [25] or confusing presentations[26,27] on arrival, and minimal vital signs deterioration. Both Acute Coronary Syndromes (ACS) and Stokes are among the leading causes of death and disability and early recognition and timely intervention is critical. As stated earlier, EWS underperform compared to specialty-specific scores[28]. To detect these patients that have slipped through the first two triage layers an extra layer is added consisting of disease specific scores.

Many scores are in use to help identify patients with these conditions promptly and accurately. Most commonly used to detect ACS are the Thrombosis in Myocardial Infarction risk (TIMI) score, Global Registry of Acute Coronary Events (GRACE) score, The HEART score. Likewise the National Institutes of Health Stroke Scale (NIHSS), Cincinnati Prehospital Stroke Severity Scale (CPSSS), Rapid Arterial Occlusion Evaluation (RACE), Face Arm Speech Test (FAST), Medic Prehospital Assessment for Code Stroke (MedPACS), Recognition of Stroke in the Emergency Room (ROSIER) are used for the early recognition of stroke.

The HEART score seems to perform better that other scores in detecting ACS [29,30]. In the mnemonic HEART, each letter corresponds to a key piece of the evaluation for patients with chest pain: History, ECG, Age, Risk factors, and Troponin. Each component was scored on a scale of 0–2, with total scores ranging between 0–10 (Figure 4). The calculated score corresponds to the short term probability of a major adverse cardiovascular event (MACE) and appropriate action is recommended[36] (Figure 5).

HEART Score		
Element	Assessment	Points
History	Highly suspicious	2
	Moderately suspicious	1
	Slightly suspicious	0
Electrocardiogram	Significant ST depression	2
	Nonspecific repolarization disturbance	1
	Normal	0
Age	≥ 65 years	2
	45-65 years	1
	< 45 years	0
Risk factors	≥ 3 risk factors or history of atherosclerotic disease	2
	1 or 2 risk factors	1
	No risk factors known	0
Troponin	> 2x normal limit	2
	1-2x normal limit	1
	≤ normal limit	0

Figure 4. The HEART score[38].

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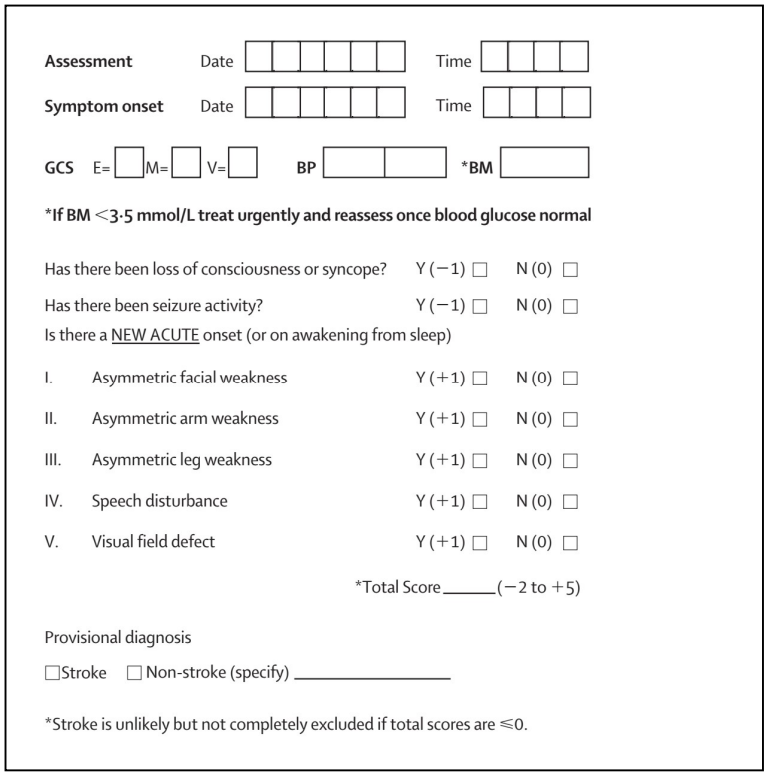
Score	MACE	Mace over the next 6 weeks	Action
0-3	1,6%	2,5%	Early discharge
4-6	13%	20,3%	Clinical observation and non-invasive investigations
7-10	50%	72,2%	Early aggressive treatmrnt

Figure 5. HEART score interpretation and stratification. (MACE = Major adverse cardiac events).

For detecting stroke in the Emergency Department In the ROSIER could be the test of choice, as it has been well evaluated and showed consistently high sensitivity[31,32]. The ROSIER scale is a 7-item stroke recognition instrument employing clinical history and neurological signs, ranging from-2 to +5. A score of +1 or higher indicates a positive diagnosis of stroke or transient ischemic attack (TIA). The scale encompasses assessment criteria such as loss of consciousness, seizure activity, asymmetric facial, arm, and leg weakness, speech disturbance, and visual field deficit. (Figure 6).



Assessment Date ☐☐☐☐☐☐ Time ☐☐☐☐

Symptom onset Date ☐☐☐☐☐☐ Time ☐☐☐☐

GCS E=☐ M=☐ V=☐ **BP** ☐☐☐ ***BM** ☐☐☐

***If BM <3·5 mmol/L treat urgently and reassess once blood glucose normal**

Has there been loss of consciousness or syncope? Y (−1) ☐ N (0) ☐

Has there been seizure activity? Y (−1) ☐ N (0) ☐

Is there a NEW ACUTE onset (or on awakening from sleep)

I. Asymmetric facial weakness Y (+1) ☐ N (0) ☐

II. Asymmetric arm weakness Y (+1) ☐ N (0) ☐

III. Asymmetric leg weakness Y (+1) ☐ N (0) ☐

IV. Speech disturbance Y (+1) ☐ N (0) ☐

V. Visual field defect Y (+1) ☐ N (0) ☐

*Total Score _____ (−2 to +5)

Provisional diagnosis

☐Stroke ☐Non-stroke (specify) _____

*Stroke is unlikely but not completely excluded if total scores are ⩽0.

Figure 6. Rosier score [37]. BM, blood glucose; BP, blood pressure (mm Hg); GCS, Glasgow Coma Scale; E=eye; M=motor; V=verbal component.

Summarizing. Adding ROSIER and HEART score as an extra layer to our triage process minimizes the chance of under triaging a life threatening, time sensitive disease. In order to perform these scores certain blood tests are necessary. Blood glucose levels and troponin are essential parts of the algorithm. These creates certain logistic needs (Point on care devices, blood sampling, personnel etc) that have a great impact on triage time. Depending on the setup, this might take from 10 to 30 minutes. In departments like ours with long waiting times there is a clear benefit as under-triaged

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patients might lose their therapeutic window. The number of patients that end at this arm of our triage process is small and has minimal effect on door to triage time for new incomings.

3. Proposing a Multilayer Triage System

Having an in depth understanding of our Emergency Departments strengths and weaknesses and experience on conducting Triage by ESI alone we had identified areas of improvement of our triage process. Prior to introducing our institutional multilayer triage (Figure 7) system an extensive and critical review of the literature was conducted. We combined the strong points of each score to better fit our needs. ESI would quickly and accurately identify the majority of very high acuity patients (Priority 1). ESI along with specific symptom clusters from ATS, MTS and CTAS "Red flags" were used to identify quickly and accurately our high acuity patients (Priority 2). Acknowledging that almost 20% of Priority 1 and 2 patients might be under-triaged by ESI we introduced NEWS 2 score as a second layer. Besides increasing our priority 1 and 2 detection rate this addition also helped in better interpretation of vital signs, objective and reproducible allocation of priority 3 and priority 4 patients. As an added benefit, it created an objective benchmark to which the patient's improvement or deterioration over time and response to treatment could be compared. ACS and Stroke detection where a priority and a third layer consisting of Rosier and HEART score was added allocating patients to priority 2 or 3 or 4. Those patients who at the end of the triage process were characterized as low acuity where prioritized as priority 4 or priority 5 according to the estimated extent of investigation needed according to combined elements of the ESI (resources) and CTAS (age and comorbidities). Table 2 summarizes our priority allocation tools and scheme 1 depicts our triage process.

Table 2.

Patient Priority	**Clinical condition**	**Tools used to identify**
Priority 1	Immediate risk for life or limb	ESI
Priority 2	Serious enough or deteriorating so rapidly	ESI **and/or** Red Flags **and/or** NEWS 2>7 **and/or** HEART score >7 **and/or** Rosier >1
Priority 3	Not serious enough, but could have atypical or early presentation of a serious condition	NEWS 2=5-6 **and/or** HEART score =4-6
Priority 4	No serious underlying condition, but will require extensive work up	ESI **and** NEWS 2=0-4 **and** HEART =0-3 **and** Rosier ≤0
Priority 5	Acute but non-urgent or chronic problem without deterioration. Need minimum investigation	ESI **and** NEWS 2=0-4 **and** HEART =0-3 **and** Rosier <0

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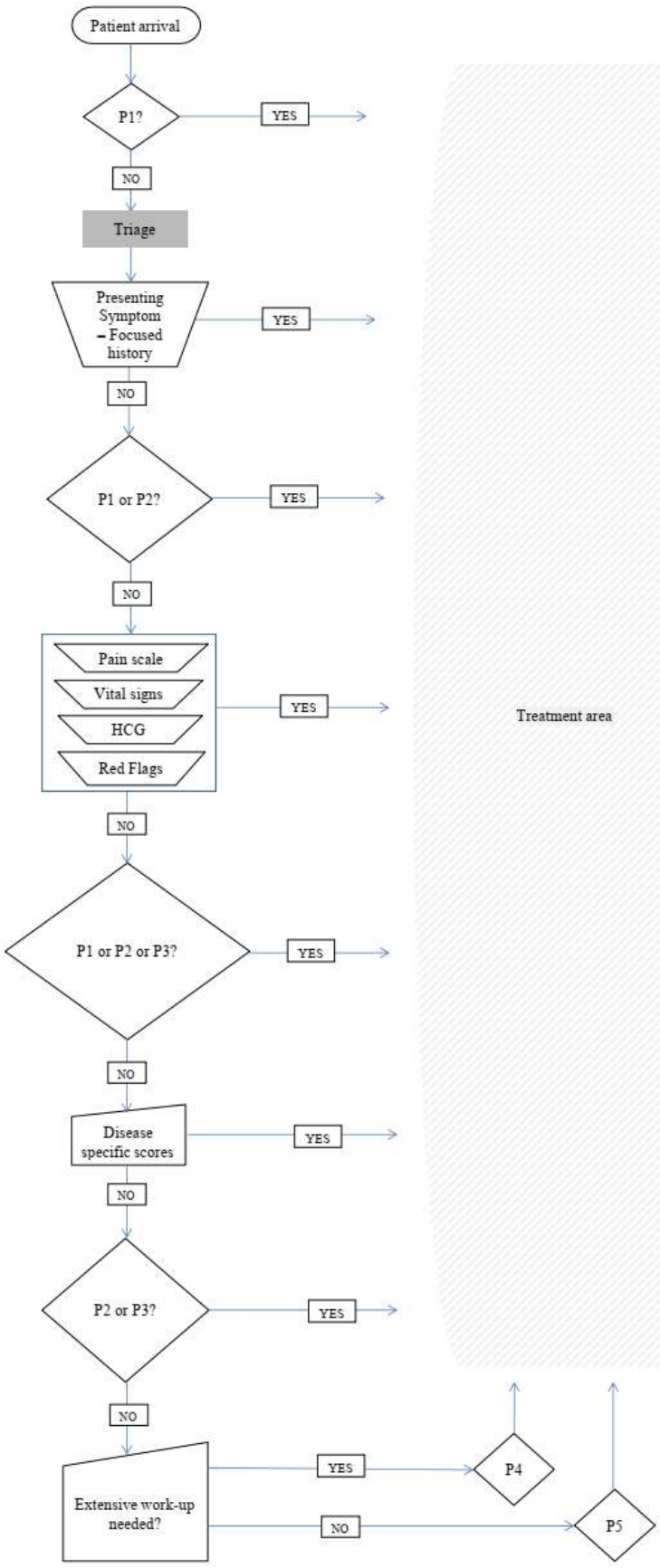

Figure 7. Scheme 1: The multilayer triage flow chart.

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The steps of the multilayer triage system are as follows

a. **Seeking Priority 1 patients** – Clinical impression
    a. Use the basic principles of clinical impression triage systems such as ESI
    b. "Is there immediate risk for life or limb?"
    c. If the answer is YES the patient is Priority 1
    d. In the answer is NO proceed to the next step

b. Seeking Priority 2 Patients – Basic History taking and clinical impression
    a. Use the basic principles of clinical impression triage systems such as ESI
    b. "Is patient's condition serious enough or deteriorating so rapidly that there is the potential of threat to life, or organ system failure?"
    c. "Is the patient in severe pain?"
    d. "Does the patient have altered mental status?"
    e. "Are there any "Red Flags"?" CTAS, ATS, MTS
    f. If the answer is YES to any of the above questions, the Patient is Priority 2
    g. If the answer is NO proceed to the next step

c. Are you sure the Patient is NOT Priority 1 or 2 ? – Vital signs
    a. Use NEWS 2 to interpret vital signs
    b. Prioritize patient according to the EWS you have chosen
        i. NEWS2 Score > 7 the patient is priority 2
        ii. NEWS2 Score 5-6 or red score of 3 in any individual parameter, the patient is priority 3
        iii. NEWS2 Score 0-4 Proceed to the next step

d. Could the patient have an atypical presentation of a time-sensitive disease? – Disease specific scores
    a. Use one of the accredited disease-specific scores depending on the clinical question.
    b. Prioritize the patient according to the score you have chosen.
    c. Use the HEART score for a possible ACS
        i. For a HEART score 7-10 the patient is priority 2
        ii. For a HEART score between 4-6 the patient is priority 3
        iii. For a HEART score 0-3 proceed to the next step
    d. Use Rosier score for a possible stroke
        i. For Rosier >1 the patient is priority 2
        ii. For Rosier ≤ 0 proceed to the next step

e. Will this patient require extensive work-up? – Focused history taking
    a. Use the basic principles of clinical impression triage systems such as ESI, CTAS
    b. "Will the patient, due to his age or comorbidities, require extensive work-up?"
    c. If the answer is YES the patient is Priority 4
    d. If the answer is NO the Patient is Priority 5.

4. Results

Having implemented this multi-layer triage system for our adult population for more than 3 years we have had almost no critical events in the waiting room. Less than 5% of patients in the

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waiting room will need to change to a higher priority category while waiting. There is a very high level of agreement of the triage category between triage personnel of different training backgrounds. Although not systematically recorded over triage is bellow 15%. Our average triage time remains at 10 minutes. Even for the most complex arms of the chart triage time never exceeds 25 minutes without prolonging our door to triage time. Having created an objective and reproducible system training, reviewing and quality control have become easier. More recently we have created and started implementing an artificial intelligence decision assistance tool built on these parameters.

Re-structuring the triage process alone has had multiple downstream effects with a positive impact on triage accuracy. A structured training program was implemented for triage personnel. Constant and systematic training of triage personnel has been shown to have a clear impact on triage quality. Our Triage training program is being gradually adopted across Greece. Due to the new triage system, charting and recording had to be re-structured. Complete charting and strict adherence to the triage process have been identified as major contributors to high-quality triage. Re-triage at set time intervals was introduced as part of the quality control of the multilayer triage system. This created a re-Triage culture that has remained. Even during our initial needs assessment and planning of the triage system, a number of ED throughput issues were identified and addressed accordingly.

5. Conclusion

Triage is the most vital part of ED operations and can have a great impact on ED flow and patient outcomes. The perfect triage system does not exist. Comparing different triage models is very difficult as this is a multi-factorial process depending on input and output of patients, ED resources, staffing and hospital capabilities, training background of triage personnel etc. Each Emergency Department must clearly identify it's own needs and tailor a triage process to fulfill them.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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