Emergency department acuity measurement and process

Quick Scoping Review

March 2023

Contents

1. Glossary

4C Score	4C Mortality Score
FI-CGA	57-item deficit accumulation frailty index
AIS	Abbreviated Injury Scale
abbMEDS	Abbreviated Mortality Emergency Department Sepsis score
AHFI	Acute heart failure index
APACHE II	Acute Physiology and Chronic Health Evaluation II score
Age SI	Age shock index
AWTT	Alcohol withdrawal triage tool
MAT/SET	Andorran Triage Model/Spanish Triage System
ASQ	Ask Suicide Screening Questions
ATS	Australasian Triage Scale
BPA	Best-practice alert) -automated sensitive triage tool
CTAS	Canadian Triage and Acuity Scale
CAS	Clinical Asthma Score
CDSS	Clinical Decision Support System
CRPT	Colour-Risk Psychiatric Triage
ca-ISET	Computer-assisted instrument of self-triage
DEPT	Danish Emergency Process Triage
DECAF	dyspnoea, eosinopenia, consolidation, acidaemia, atrial fibrillation
DTAS	Deep-learning-based Triage and Acuity Score
CAT	Department of Health community assessment tool
DGP	Dynamic Grouping and Prioritization (DGP) algorithm
EWS	Early Warning Score
ELISA	Echelle Liegeoise d'Index de Severite a l'Admission
SOFA	ED Sequential Organ Failure Assessment score
eCTAS	Electronic Canadian Triage and Acuity Scale
ePNa	Electronic Clinical Decision Support (CDS) for pneumonia
EDACS	Emergency Department Assessment of Chest Pain Score
TREWS	Emergency Department Triage Early Warning Score
EHMRG	Emergency Heart Failure Mortality Risk Grade score
ESI	Emergency Severity Index
EIS	Estimation of illness severity
EMR-ESI	Excess mortality ratio-based Emergency Severity Index
FAST-ED	Field Assessment Stroke Triage for Emergency Destination scale
GAPS	Glasgow Admission Prediction Score
GRACE	Global Registry of Acute Coronary Events score
GRSS	Global respiratory severity score
HIDAT	Head Injury Discharge At Triage tool
HITSNS	Head Injury Straight to Neurosurgery triage rule
HAPT	Hillerod Acute Process Triage system
HEART	History, Electrocardiogram, Age, Risk factors and Troponin score
HASTA	Hyper Acute Stroke Alarm
ISAR	Identification of Seniors at Risk
IRS	Illness Rating Score
ITA	Incident triage area
O2 sat	Initial O2 saturation
ISS	Injury Severity Score
IGSA	Irritant gas syndrome agent triage algorithm
JTAS	Japanese Triage and Acuity Scale
KTAS	Korean Triage and Acuity Scale

LAMS	Los Angeles Motor Scale
MTS	Manchester Triage System
MPDS	Medical Priority Dispatch System
MEWS	Modified Early Warning Score
ViEWS-L	Modified early warning score with rapid lactate level
mESI	Modified emergency severity index
Modified HEART	Modified History, Electrocardiogram, Age, Risk factors and Troponin score
mJTAS	Modified Japanese Triage and Acuity Scale
mPEWS	Modified Paediatric Early Warning Score
mREMS	Modified Rapid Emergency Medicine Score
MSI	Modified shock index
MEDS	Mortality in emergency department sepsis (MEDS) score
MODS	Multiple Organ Dysfunction Score
NEWS	National Early Warning Score
NEWS2	National Early Warning Score 2
NIHSS	National Institutes of Health Stroke Scale
NTS	Netherlands Triage System
OTAS	Objectified Korean Triage and Acuity Scale
OTAS	Obstetric Triage Acuity Scale
OTDA	Obstetric triage decision aid
PAT	Paediatric Assessment Triangle
PedCTAS	Paediatric Canadian Triage and Acuity Scale
PEWS	Paediatric Early Warning Score
POPS	Paediatric Observation Priority Score
PRAM	Paediatric Respiratory Assessment Measure
pSOFA	Paediatric Sequential Organ Failure Assessment score
Ped-TTAS	Paediatric Taiwan Triage and Acuity System
Ped-TTS	Paediatric Taiwan Triage System
PMEWS	Pandemic Modified Early Warning Score
PP	Paramedic Pathfinder
PIRO	Predisposition, infection, response and organ failure
Ph-ViEWS	Prehospital National Early Warning Score
PreNEWS2-L	Prehospital National Early Warning Score 2 Lactate
PEDS	Prince of Wales ED Score
PMTS	Princess Marina Triage Scale
qSOFA	Quick Sequential Organ Failure Assessment (qSOFA) score
QLT	Quick-look triage approach
RTS	Ramathibodi Triage System
RAPS	Rapid Acute Physiology Score
REMS	Rapid Emergency Medicine Score
RETTS-HEV	Rapid Emergency Triage and Treatment System - Hospital Unit West
RETTS	Rapid Emergency Triage and Treatment System
RETTS-A	Rapid Emergency Triage and Treatment System-Adult (RETTS-A) triage
RETTS-p	Rapid Emergency Triage and Treatment System-paediatrics
ROSIER	Recognition Of Stroke In the Emergency Room
RASI	Respiratory adjusted shock index
REDS	Risk-stratification of Emergency Department suspected Sepsis score
SERP	Score for Emergency Risk Prediction
STTGMA	Score for Trauma Triage in the Geriatric and Middle-Aged
SAFE-T	Senior Streaming Assessment Further Evaluation after Triage

SOFA	Sequential Organ Failure Assessment
SI	Shock Index
SPS	Simple Prognostic Score
START	Simple Triage and Rapid Treatment
SAPS II	Simplified Acute Physiology Score II
SAPS III	Simplified Acute Physiology Score III
SALT	Sort, Assess, Lifesaving Interventions, Treatment/Transport
SRTS	Soterion Rapid Triage System
SATS	South African Triage Scale
META	Spanish Prehospital Advanced Triage Method
SCAT-3	Sport Concussion Assessment Tool version 3
SFAHP	Swine flu adult hospital pathway
START	Sydney Triage to Admission Risk Tool
SAA	Symptom Assessment Application
SIRS	Systemic Inflammatory Response Syndrome score
TPTS	Taiwan Prehospital Triage System
TTAS	Taiwan Triage and Acuity Scale
TemCOV	Temple COVID-19 Pneumonia Triage Tool
FLHASc	The Florence Haemoptysis Score
TLTS	Three-level triage scale
TIMI	Thrombolysis in myocardial infarction risk score
TAPS	Triage Algorithm for Psychiatric Screening
TIMM	Triage Information Mortality Model
TL	Triage level
TQAS	Triage Quality Assessment Software
TRST	Triage Risk Stratification Tool
TSS	Triage scoring system
VEWS	Vitalpac Early Warning Score
WEST	West coast System for Triage

2. Executive Summary

Background

This review was commissioned by NHS England to inform the Acuity Standardisation Project which aims to agree a standardised method of allocating acuity category (a triage method) for Emergency Departments (EDs) and Urgent Treatment Centres (UTCs) in England. The purpose of the review is to map the evidence base and summarise key sources of evidence on the application of existing models of triage.

For clarity, acuity has been defined by the Acuity Standardisation Project as "*the requirement for a time-critical intervention to prevent or reduce mortality or morbidity*". In the studies we identified, a range of different outcome measures have been used to assess the predictive value of the tools, notably: admission (to hospital or to intensive care units (ICU)), mortality, resource use and costs. The majority of these outcomes do not reflect acuity as defined by this project.

Methods

This review has been necessarily pragmatic to provide a rapid summary of key papers on acuity assessment tools. Our search and screening processes have not been exhaustive and we have not critically appraised individual papers. The method is described in detail in *Appendix 1: Our approach to the review*.

We searched several databases to find potentially relevant publications for this project. The papers that were the most relevant from these databases were included in an Evidence Map, and a small subset of those papers were looked at in detail. These were selected to be representative of the evidence on how useful acuity assessment tools were in a general population attending ED in the UK or a similar country, and the data from these 19 papers has been included in the summary tables and charts in Section 5 of this report. It is important to note that these 19 papers are the best examples we could find of the evidence on this topic but they do not represent all the research that has been conducted in this area.

We have supplemented the data from these 19 papers by also collating information from the abstracts of the other papers indexed in the Evidence Map into the tables on how effectiveness has been measured and what outcomes have been used to assess the acuity tools (Table 3 and 4 in Section 4), and an overall summary of which tools have been used in different subgroups (Table 2 in Section 4). We also added more information from the abstracts of other publications that were not included in the Evidence Map into the table on what tools have been used in a general ED population (Table 2 in Section 4). To keep this review within a realistic scope the full papers of the studies summarised in these tables were not reviewed, so the data in the tables is based only on the information in the abstract summary of each paper. As such, some relevant information from each study may be missing.

Findings

Of the 19 studies included in the review, 7 were prospective observational studies of 100 to 2,000 participants, 6 were retrospective observational studies of 2,812 to 81,520 participants, 2 were cross-sectional studies of 151 to 233 participants, 2 were systematic reviews with a total of 973,099 to 1,433,020 participants, and 2 were systematic reviews and meta-analyses with a total of 29,094 to 2,216,584 participants.

The review addressed four key questions:

What models, systems and tools are being used to define and determine acuity in ED?

We identified over 110 tools used for acuity assessment in patients attending Emergency Departments (ED). We provide a summary detailing the range of population types and settings where tools were used, the country in which the research was conducted, and whether the validity of the tool has been assessed. The main tools identified in the literature are:

- Australasian Triage Scale (ATS)
- Canadian Triage and Acuity Scale (CTAS)
- Emergency Severity Index version 4 (ESI)
- Hong Kong 3-level Triage Scale (HK3TS)
- Illness Rating Score (IRS)
- Manchester Triage System (MTS)
- Modified Early Warning Score (MEWS)
- Ramathibodi Triage System (RTS)
- Rapid Emergency Medicine Score (REMS)
- Triage in Emergency Department Early Warning Score (TREWS)

Methods of validation published in the literature include: assessing the area under the receiver-operator curve (AUC); inter-rater reliability; sensitivity; specificity; positive predictive value (PPV); negative predictive value (NPV); ease of use or undertriage and overtriage rates (mistriage).

What evidence is there on the effectiveness of these models, systems, and tools?

The sensitivity, specificity, and other measures of effectiveness vary across studies for the same tool, therefore the context in which the tool is used clearly affects its accuracy. Several studies reported on undertriage and overtriage rates, although these were not usually defined, so it is unclear whether these rates are comparable across studies.

Studies that have reported inter-rater reliability have generally found good reliability for the tools assessed within the same professional group (e.g., physicians, nurses) but less good reliability comparing scores from physicians and nurses. Information is provided from 40 studies which tested tool performance. We have provided charts to give an indication of the comparative accuracy of each tool, but these are not based on a formal statistical comparison or meta-analysis where study heterogeneity has been considered. There did not appear to be any one tool with a substantially better performance than the others for predicting important clinical outcomes.

Nine studies compared different tools, including one meta-analysis of 50 studies.

Citation	Population and setting	Findings
Aeimchanbanjong et al. (2017)	Children up to age 15 years in Thailand in 2015	AUC results: Emergency Severity Index (ESI): 0.78 Australasian Triage System (ATS): 0.73 Manchester Triage System (MTS): 0.70 Ramathibodi Triage System (RTS): 0.66 Canadian Triage and Acuity Scale (CTAS): 0.64
Bulut et al. (2014)	2,000 adults attending ED in Turkey in 2011-2012	A cut-off score for MEWS of 5 was able to discriminate between patients likely to die in hospital, with a risk of death 3.837 times higher (95%CI 2.358 to 6.243, $p<0.001$) for those with a score ≥5 compared with <5. A cut-off score for REMS of 6 was also able to discriminate between patients likely to die in hospital, with a risk of death 2.923 times higher (95%CI 0.026 to 4.217, $p<0.001$) than those with a score <6.
De Magalhaes et al (2017)		The original MTS had a moderate sensitivity of 63% that led to overtriage in 47% and undertriage in 15%. A modified version of the MTS had similar sensitivity but higher specificity, which was associated with a reduced overtriage rate (47%) but similar undertriage rates (15%). The SATS had a positive predictive value of only 37.5% and negative predictive value of 95.3%, leading to overtriage in 45.5% of patients and undertriage in 9%. The PATS had lower overtriage rates (28.8%) but higher undertriage rates (21.9%). The ESI had the smallest rates of overtriage (16%) and undertriage (11%). However, the accuracy of the ESI varied by geographical location, with heterogeneous outcomes particularly seen outside of North America. Comparable accuracy data was not reported reliably for the pediatric CTAS.
Hinson et al (2019)	Meta-analysis of 50 studies	For ED and 1-day mortality, the sensitivity was highest for MTS and ESI in a general population, with high sensitivity also recorded for CTAS in children. Specificity was higher for CTAS and ESI than NTS in a general population. For ICU admission, sensitivity and specificity of MTS varied by study but was generally high in a general population, while ESI had very high sensitivity but relatively low specificity in children compared with CTAS and MTS.

Citation	Population and setting	Findings
Hong et al. (2015)	233 adults attending ED in the US in 2011	The sensitivity of START was substantially lower than ESI for predicting the presence of abnormal vital signs, need for emergency intervention and admission (33.3% to 51.0% with START vs 87.8% to 97.9% with ESI), but the specificity of START was substantially higher than ESI (61.6% to 69.3% with START vs 15.2% to 23.4% with ESI).
Lee et al. (2020)	81,520 adults attending ED in Korea in 2010 to 2017	In both the derivation group and the validation group, TREWS (Triage in Emergency Department Early Warning Score)had a significantly higher AUC for 24-hour and 48-hour mortality than the National Early Warning Score (NEWS), Modified Early Warning Score (MEWS) and Rapid Emergency Medicine Score (REMS).
Schinkel et al. (2022)	12,317 adults presenting to ED in the Netherlands in 2018-2020	The Modified Early Warning Score (MEWS) was more accurate than the Netherlands Triage System, a modification of the Manchester Triage Scale, at predicting hospital admission among 12,317 adults presenting to ED in the Netherlands in 2018-2020. The AUC was 0.65 with MEWS and 0.60 with NTS ($p<0.001$). The study showed that early warning scores may be more accurate than complaint-based acuity assessment scales at predicting hospital admission and 30-day mortality.
Vredebregt et al. (2019)	2812 children under 16 years of age presenting at ED in the Netherlands in 2015-2016	At an optimal cut-off score of 5, the MPEWS had a sensitivity of 80% and specificity of 85%, with a PPV of 1.8% and NPV of 100%. At this threshold, the AUC for MPEWS was the same as that of the MTS. The MPEWS was not able to predict hospitalisation, however, with an AUC of 0.57
Zachariasse et al. (2019)	systematic review of 66 studies	Differences in outcome definitions and reference standards meant that no overall meta-analysis could be conducted. Although there were differences across studies in sensitivity and specificity for each tool, there were no clear differences between tools for identifying high-urgency and low-urgency patients.

Six primary studies (Aeimchanbanjong et al., 2017; Ebrahimi et al., 2020; Green et al., 2012; Lam et al., 2020; Lin et al., 2013; Ng et al., 2019) assessed interrater reliability. Tools assessed included:

- RTS,
- Australasian Triage Scale (ATS),
- Emergency Severity Index (ESI),
- Manchester Triage System (MTS),

- Pediatric Canadian Triage and Acuity Score (paedCTAS),
- Hong Kong 3-level Triage Scale (HK3TS),
- Taiwan Triage and Acuity Scale (TTAS).

We found one meta-analysis (Hinson et al., 2019) which synthesised findings from 50 studies. Inter-rater reliability, all assessed in nurses, varied considerably across studies for each tool and ranged from 0.4 to 0.84 for unweighted kappa and between 0.52 and 0.95 for weighted kappas.

Three studies assessed the performance of just one tool, all small studies from a single centre. Only one (Lam 2020) reported on the use of an actual tool, the others assessing an illness rating analogue scale (O'Neill 2021) or expert "gut feelings" (Wiswell 2013).

How have these models, systems and tools been implemented? What factors enable or inhibit implementation?

We identified only three papers which addressed implementation which reported on:

- An evaluation of a new acuity assessment process based on the use of the Early Warning Score (EWS) in conjunction with the Manchester Triage System (MTS) in the emergency department (ED) of a large hospital in Ireland. Further training was deemed necessary to improve staff performance in the use of MTS and EWS. An audit of ED presentations 6 weeks after the follow-up training showed improvement in the accuracy of acuity assessment categorisations by ED staff.
- The implementation of a "RAPID" (Rapid Assessment Plan Intervention and Disposition) team concept in the emergency department (ED) of an urban community hospital in the United States. Champions from nursing management were actively involved in socialising the new process with ED staff.
- The implementation of a Quality improvement project (QIP) called "Embedding Emergency Severity Score (ESI)" in the ED of a healthcare facility located in the United States. Qualitative analysis of RNs' self-reflection surveys before and after "embedding ESI" revealed that they were satisfied with the acuity assessment process and the electronic, acuity assistance template (ESI) embedded in the EMR.

How and why does implementation vary across contexts?

This review did not find enough studies to be able to analyse the difference in implementation across contexts.

Conclusion

Given the group's definition of acuity, this extensive review has demonstrated a paucity of evidence for any existing acuity assessment tool in identifying truly relevant outcomes.

3. Introduction

This review was commissioned by NHS England to inform the Acuity Standardisation Project which aims to agree a standardised method of allocating acuity category (a triage method) for Emergency Departments (EDs) and Urgent Treatment Centres (UTCs) in England.

The purpose of the review is to map the evidence base and summarise key sources of evidence on the application of existing models of triage. The review addressed the following questions:

- What models, systems and tools are being used to define and determine acuity in ED?
- What evidence is there on the effectiveness of these models, systems, and tools? How is effectiveness measured (e.g., consistency/interrater reliability; usability/ease of use etc)? What outcome measures are used (e.g., death, hospital admission, Intensive Care Unit (ICU) admission)?
- How have these models, systems and tools been implemented? What factors enable or inhibit implementation?
- How and why does implementation vary across contexts?

The review was based on the Quick Scoping Review method[1], developed in the civil service to inform policy and strategy decisions. The review protocol was agreed with the project advisory group at the start of the project and subsequent decisions were agreed via fortnightly project group meetings. Details of the approach taken are provided in *Appendix 1: Our approach to the review*.

The review is accompanied by an evidence map (access is restricted to the project advisory group): https://maps.evidencemapper.co.uk/map/measures-for-assessing-acuity-in-the-emergency-department/cover. The map provides an overview of the evidence base (187 abstracts in total), enabling the user to view the evidence according to the following categories:

- Acuity measure: the name of the tool or process used to assess acuity.
- Disease: any specific disease areas being assessed within a more general population of patients attending the ED.

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1 https://webarchive.nationalarchives.gov.uk/ukgwa/20140402164155/http://www.civilservice.gov.uk/networks/gsr/resources-and-guidance/rapid-evidence-assessment

- Location: the country in which the research was conducted (or author address, if no other information reported).
- Outcomes: the consequences of the acuity assessment being reported, e.g., mortality rates, admission rates, time to admission.
- Setting: the place where acuity was assessed, e.g., ED, Pre-ED.
- Study methodology: the type of study being conducted e.g., Validation study, Systematic review, Prospective observational study.
- Study size: the number of patients or healthcare staff being assessed, in bands.
- Subpopulation: the age group or professional status of the study participants.
- Year: the year of publication of the paper.

The review has been conducted by a team working in collaboration across the Strategy Unit and Crystallise, with clinical advisory input from Dr Kirsty Challen, Consultant in Emergency Medicine. Additional support has been provided by the project advisory group (see Appendix 2).

The Strategy Unit.

The Strategy Unit is an NHS team specialising in multi-disciplinary analytical work. Our proposition is simple: better evidence, better decisions, better outcomes. Our Evidence and Knowledge Mobilisation team specialise in making sense of complex evidence to help decision makers understand the implications and potential impacts of their choices.

Crystallise

The Crystallise Reviews team comprises 20 health science graduates including 16 with higher qualifications in medicine, pharmacy, public health and psychology, with more than 60 years' collective experience in conducting systematic, targeted and rapid literature reviews for the pharmaceutical and healthcare sectors.

4. What models, systems and tools are being used to define and determine acuity in ED?

The full range of tools that have been assessed for acuity assessment in patients attending Emergency Departments (ED) is reported in *Table 2*. This table shows the range of population types and settings where the tool was used, the country in which the research was conducted, and whether or not the validity of the tool has been assessed.

The information has been taken from the abstracts that were indexed in the Evidence Map (in black in the table), and other abstracts that were identified as reporting on the use of a tool for acuity assessment during abstract screening but were not included in the Evidence Map (in **blue font** in the table). Studies included in the Evidence Map (in black) were those that evaluated the effectiveness of an acuity assessment tool, while those that were not included in the Map (in blue) reported that a measure had been used but did not evaluate its accuracy. Please note that the data in *Table 1* is all based on the information reported in the abstracts of these publications, not the full texts.

The citations of the studies where these tools were used are reported in *Appendix 3: Citations of studies reporting use of acuity assessment tools.* A brief description of the main acuity assessment tools is provided in *Table 1*.

Table 1: Description of main acuity assessment tools

Tool	Description	Recommended Response Time Per Acuity Level
Manchester Triage System (MTS)	MTS features 52 presenting complaint flowcharts, of which 49 are suitable for children. Based on the flowcharts, general discriminators such as life-threatening conditions and conscious level are considered. Selected discriminator identifies urgency level. Medical care should be delivered immediately for level 1, within 10 minutes for level 2, within 60 minutes for level 3, within 120 minutes for level 4 and within 240 minutes for level 5. (Kanokwan Aeimchanbanjong, 2017)	Level 1: immediately Level 2: within 10 minutes Level 3: within 60 minutes Level 4: within 120 minutes Level 5: within 240 minutes
Emergency Severity Index version 4 (ESI)	Patients requiring immediate life-saving interventions who must be seen immediately (based on practitioner gestalt) are level 1. Patients in high-risk conditions, who are confused, lethargic, disoriented, having severe pain, distress and highly abnormal vital signs and should be seen within ten minutes, are level 2. Level 3 is for patients who are expected to require two or more resources, which can be diagnostics in term of laboratory investigations or electrocardiogram. Level	Level 1: immediately Level 2: within 10 minutes Level 3: Not specified Level 4: Not specified Level 5: Not specified

Tool	Description	Recommended Response Time Per Acuity Level
	4 is for patient who are expected to require one resource, and level 5 if no resources are expected to be required. The specific flowchart for children with fever was added in the fourth version of ESI. (Kanokwan Aeimchanbanjong, 2017)	
Canadian Triage and Acuity Scale (CTAS)	Based on a list of patients presenting complaints with first- and second-order modifiers for specific conditions. Its principle operational objective determines the time for the patient's initial assessment by a physician. Medical care should be delivered immediately for level 1, within 15 minutes for level 2, within 30 minutes for level 3, within 60 minutes for level 4 and within 120 minutes for level 5. (Kanokwan Aeimchanbanjong, 2017)	Level 1: immediately Level 2: within 15 minutes Level 3: within 30 minutes Level 4: within 60 minutes Level 5: within 120 minutes
Australasian Triage Scale (ATS)	Primary triage decisions are based on the triage assessment, allocation of a triage category and patient deposition. Secondary triage decisions are based on the initiation of nursing interventions for emergency care and patient comfort. Medical care should be delivered immediately for level 1, within 10 minutes for level 2, within 30 minutes for level 3, within 60 minutes for level 4 and within 120 minutes for level 5. (Kanokwan Aeimchanbanjong, 2017)	Level 1: immediately Level 2: within 10 minutes Level 3: within 30 minutes Level 4: within 60 minutes Level 5: within 120 minutes
Ramathibodi Triage System (RTS)	RTS has five levels based on chief complaint and vital signs. Criteria of each level of triage were constructed by experts and specialists. Medical care should be delivered immediately for level 1, within 30 minutes for level 2 and non-urgency for levels 3, 4, 5. (Kanokwan Aeimchanbanjong, 2017)	Level 1: immediately Level 2: within 30 minutes Level 3: Non-urgency Level 4: Non-urgency Level 5: Non-urgency
Hong Kong 3-level Triage Scale (HK3TS)	Simplified 3-level triage system based on the Hong Kong Accident and Emergency Triage Guidelines (HKAETG) 5-level triage system. The assigned triage category is based on the nurse's global assessment of the patient's chief complaint and vital signs. (Lam et al., 2020)	Level 1: Not specified Level 2: Not specified Level 3: Not specified
Illness Rating Score (IRS)	The IRS survey asked two questions: a sliding visual analogue scale to ask: "How ill does this patient appear?" from 0 (totally well) and 10 (critically ill); a think-aloud verbal response: "Please explain your clinical reasoning for your above assessment." (O'Neill et al., 2021)	Not specified
Modified Early Warning Score (MEWS)	Based on regular assessment of five basic physiologic parameters (systolic blood pressure, pulse rate, respiratory rate, temperature, AVPU score), assigning a number ranging from 0 to 3 to each. A score of 5 and over is evaluated as 'critical score'. Critical score is associated with increased mortality rate or admission to ICU. Patients were classified as	Not specified

Tool	Description	Recommended Response Time Per Acuity Level
	high risk (≥5) or low risk (13), intermediate risk (6–13), and low risk (<6). (Bulut et al., 2014).	
Rapid Emergency Medicine Score (REMS)	REMS is a scoring system based on five physiologic parameters (mean arterial pressure, respiratory rate, blood pressure, peripheral O2 saturation and GCS score) and age. Except for age (0–6 points), each parameter is graded from 0 to 4, and the maximum score is 26. According to REMS, patients were classified as high risk (>13), intermediate risk (6–13), and low risk (<6). (Bulut et al., 2014).	Not specified
Triage in Emergency Department Early Warning Score (TREWS)	The TREWS is based on the NEWS and scores patients based on systolic blood pressure, heart rate, respiratory rate, body temperature, peripheral oxygen saturation, level of consciousness , oxygen supply and age. (Lee et al., 2020).	Not specified

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Table 2: Tools used to assess acuity

Tool	Disease	Population	Setting	Location	Validity
57-item deficit accumulation frailty index (FI-CGA)	Unspecified	Older Adult	Emergency department	Canada	Unclear
Acute Physiology and Chronic Health Evaluation II (APACHE II) score	Critical Febrile Illness, Hepatic Portal Venous Gas, Presumed Infection, Sepsis, Unspecified	Adult, Unclear	Emergency department	Australia, India, Italy, Korea, Taiwan	Yes, Unclear
Ambulatory Score (Ambs)	General	Unclear	Emergency department	 United Kingdom	Yes
Andorran Triage Model	Unspecified	Unclear	Emergency department	Spain	Unclear
Andorran Triage Model/Spanish Triage System (MAT/SET)	Heart Failure	Unclear	Emergency department	Unclear	Unclear
APOP screener	Unspecified	Older Adult	Emergency department	Netherlands	Yes

Tool	Disease	Population	Setting	Location	Validity
Australasian Triage Scale (ATS)	General, Acute Coronary Syndrome, Sepsis, Stroke	Child, Adult, Healthcare Provider, Unclear	Emergency department	Australia, Israel, International, Unclear	Yes
BPA (best-practice alert) -automated sensitive triage tool	Septic Shock	Child	Emergency department	United States	Yes
Canadian Triage and Acuity Scale (CTAS)	General, Cardiovascular Diseases, Chest Pain, Headache, Musculoskeletal Disorders, Pain, Respiratory Disorders	Child, Adult, Older Adult, Healthcare Provider, Unclear	Emergency department, Pre-hospital setting, Unclear	Canada, International, Unclear	Yes
Clinical Decision Support System (CDSS)	General, Trauma,	Unclear	Emergency department	Canada, Unclear	Yes
Clinical Frailty Scale (CFS)	Unspecified	Older Adult	Emergency department	 Canada, Ireland, United Kingdom	Yes, Unclear

Tool	Disease	Population	Setting	Location	Validity
Danish Emergency Process Triage (DEPT)	General	Unclear	Emergency department	Denmark	Yes
Deep-learning-based Triage and Acuity Score (DTAS)	General	Unclear	Emergency department	Korea	Yes
Dynamic Grouping and Prioritization (DGP) algorithm	General	Unclear	Emergency department	United States	Yes
Early Warning Scores (EWS)	General	Adult, Unclear	Emergency department, Emergency medical services, Pre-hospital setting, Urgent care settings	 Ireland, Spain, United Kingdom, International	Yes
East Midlands, North West and Northern prehospital triage tools	Trauma	Child	Emergency department	 United Kingdom	Yes
eccSOFA	Critical Illness	Adult	Emergency department	United States	Yes

Tool	Disease	Population	Setting	Location	Validity
Echelle Liegeoise d'Index de Severite a l'Admission (ELISA)	General	Unclear	Emergency department	Unclear	Yes
ED Sequential Organ Failure Assessment (SOFA) score	Trauma	Adult	Emergency department	Unclear	Unclear
Electronic Canadian Triage and Acuity Scale (eCTAS)	General	Unclear	Emergency department	Canada	No
Electronic patient self-triage	General, Cardiovascular Diseases, Respiratory Disorders	Unclear	Emergency department	 Canada, United Kingdom	Yes
Emergency Department Triage Early Warning Score (TREWS)	General	Adult, Unclear	Ambulance services, Emergency department	Korea, Spain	Yes
Emergency Nurses Association Emergency Severity Triage	Psychiatric Disease	Unclear	Unclear	United States	Unclear

Tool	Disease	Population	Setting	Location	Validity
Emergency Severity Index (ESI)	General	Child, Adult, Older Adult, Healthcare Provider, Unclear	Emergency department, Emergency medical services, Pre-hospital setting, Urgent care settings	 Belgium, Colombia, Germany, Israel, Japan, Korea, Portugal, Spain, Switzerland, United Kingdom, United States, International, Unclear	Yes
Estimation of illness severity (EIS)	Unclear	Unclear	Emergency department	United States	No
Excess mortality ratio-based Emergency Severity Index (EMR-ESI)	Unclear	Unclear	Emergency department	Unclear	Yes
Expert practitioner	General, Surgical Illness	Healthcare Provider, Unclear	Emergency department, Pre-hospital setting	United States, Unclear	Yes
Glasgow Admission Prediction Score (GAPS)	General	Unclear	Emergency department		Yes

Tool	Disease	Population	Setting	Location	Validity
				United Kingdom	
Hillerod Acute Process Triage (HAPT) system	General	Adult	Emergency department	Unclear	Yes
HOTEL score	Unspecified	Adult	Emergency department	Korea	Yes
Identification of Seniors at Risk (ISAR)	Unspecified	Older Adult	Emergency department	Italy	Yes
Illness Rating Score (IRS)	General	Child	Emergency department	United States	Yes
Interagency Integrated Triage Tool	COVID-19	Adult	Emergency department	Papua New Guinea	Yes
Japanese Triage and Acuity Scale (JTAS)	General, Acute Coronary Syndrome	Adult, Healthcare Provider, Unclear	Emergency department	Japan	Yes
Korean Triage and Acuity Scale (KTAS)	General	Adult, Unclear	Emergency department	Korea	Yes
Machine-learning risk prediction models (AI models)	General, Non-Trauma, Trauma	Adult, Healthcare Provider, Unclear	Emergency department	Australia, Denmark, Korea, Netherlands, Portugal, Spain, Taiwan, United States,	Yes

Tool	Disease	Population	Setting	Location	Validity
				International, Unclear	
Manchester Triage System (MTS)	General, Acute Coronary Syndrome, Critical Illness, Medical Illness, Surgical Illness, Pulmonary Embolism	Child, Adult, Older Adult, Healthcare Provider, Unclear	Emergency department, Pre-hospital setting, Unclear	Austria, Ireland, Netherlands, Portugal, Spain, United States, International, Unclear	Yes
Medical Priority Dispatch System (MPDS)	General	Unclear	Ambulance services	Australia	Yes
Modified Early Warning Score (MEWS)	General, Medical Illness, Surgical Illness, Trauma	Adult, Unclear	Emergency department	 Korea, Netherlands, Turkey, United Kingdom, Unclear	Yes
Modified early warning score with rapid lactate level (ViEWS-L)	Unspecified	Older Adult	Emergency department	Unclear	Yes
Modified emergency	Cancer, COVID-19	Unclear	Emergency	United States	Unclear

Tool	Disease	Population	Setting	Location	Validity
severity index (mESI)			department		
Modified Japanese Triage and Acuity Scale (mJTAS)	General	Adult	Emergency department	Japan	Yes
Modified Korean Triage and Acuity Scale	Unclear	Unclear	Emergency department	Korea	Yes
Modified Paediatric Early Warning Score (mPEWS)	Critical Illness	Child	Emergency department	Netherlands	Yes
Modified Rapid Emergency Medicine Score (mREMS)	General	Adult	Ambulance services	Spain	Yes
Multiple Organ Dysfunction Score (MODS)	Sepsis	Adult	Emergency department	India	Yes
National Early Warning Score (NEWS)	General	Adult, Unclear	Emergency department	Finland, Unclear	Yes

Tool	Disease	Population	Setting	Location	Validity
National Early Warning Score 2 (NEWS2)	General	Adult, Unclear	Ambulance services, Emergency department, Pre-hospital setting	 Colombia, Spain, United Kingdom	Yes
Netherlands Triage System (NTS)	General, Trauma	Unclear	Emergency department	Netherlands	Yes
Objectified Korean Triage and Acuity Scale (OTAS)	Unclear	Unclear	Emergency department	Korea	Yes
Ohio Department of Public Safety statewide geriatric triage criteria	Unspecified	Older Adult	Emergency department	United States	No
Ohio's 2009 emergency medical services (EMS) geriatric trauma triage criteria	Trauma	Older Adult	Unclear	Unclear	Unclear
Paediatric Assessment Triangle (PAT)	General, Cardiopulmonary Failure, Central	Child	Emergency department	Unclear	Yes

Tool	Disease	Population	Setting	Location	Validity
	Nervous System Diseases, Metabolic Diseases, Respiratory Disorders, Shock				
Paediatric Canadian Triage and Acuity Scale (PedCTAS)	General	Child	Emergency department, Pre-hospital setting	Canada, Israel, International, Unclear	Yes
Paediatric Early Warning Score (PEWS)	General, Medical Illness, Respiratory Disorders, Surgical Illness, Trauma	Child	Emergency department	 Canada, Netherlands, United Kingdom, Unclear	Yes
Paediatric Observation Priority Score (POPS)	General	Child	Emergency department, Unclear	 United Kingdom	Yes
Paediatric Sequential Organ Failure Assessment (pSOFA) score	Sepsis	Child	Emergency department	United States	Yes

Tool	Disease	Population	Setting	Location	Validity
Paediatric Taiwan Triage and Acuity System (Ped-TTAS)	General, Non-Trauma	Child	Emergency department	Taiwan, International	Yes
Paediatric Taiwan Triage System (Ped-TTS)	Non-Trauma	Child	Emergency department	Taiwan	Yes
Pandemic Modified Early Warning Score (PMEWS)	COVID-19, H1N1 Flu	Adult, Unclear	Emergency department, Pre-hospital setting	 United Kingdom, Unclear	Yes, Unclear
Paramedic Pathfinder (PP)	General	Unclear	Ambulance services	Unclear	Yes
Perfusion index measurement	Critical Illness	Unclear	Emergency department	Unclear	No
Physician-in-Triage Model	Abdominal Pain	Unclear	Emergency department	Unclear	Unclear
Pivot triage process (Pivot)	General	Unclear	Emergency department	Unclear	No
Prehospital National Early Warning Score	General	Unclear	Emergency department, Pre-	Ireland	Yes

Tool	Disease	Population	Setting	Location	Validity
(Ph-ViEWS)			hospital setting		
Prehospital National Early Warning Score 2 Lactate (PreNEWS2-L)	General	Unclear	Unclear	Spain	Yes
Prince of Wales ED Score (PEDS)	Unclear	Adult	Emergency department	 United Kingdom	Yes
Princess Marina Triage Scale (PMTS)	General	Child, Healthcare Provider	Emergency department	International	Yes
Procalcitonin (PCT) and Mid regional pro-Adrenomedullin (MR-proADM)	Critical Febrile Illness	Unclear	Emergency department	Italy	Yes
Quick Sequential Organ Failure Assessment (qSOFA) score	General	Adult	Emergency department	Korea	Yes
Quick-look triage approach (QLT)	General	Healthcare Provider, Unclear	Emergency department	Denmark, Unclear	Yes

Tool	Disease	Population	Setting	Location	Validity
Ramathibodi Triage System (RTS)	General	Child	Emergency department	Unclear	Yes
Rapid Acute Physiology Score (RAPS)	COVID-19	Adult	Emergency department	Unclear	Yes
Rapid Emergency Medicine Score (REMS)	General, Medical Illness, Surgical Illness,	Adult, Unclear	Emergency department, Pre-hospital setting	Turkey, Unclear	Yes
Rapid Emergency Triage and Treatment System - Hospital Unit West (RETTS-HEV)	General	Unclear	Emergency department	Denmark	Yes
Rapid Emergency Triage and Treatment System (RETTS)	General	Adult, Unclear	Ambulance services, Emergency department	Sweden	Yes
Rapid Emergency Triage and Treatment System-Adult (RETTS-A) triage	Traumatic Brain Injury	Older Adult	Unclear	Sweden	Unclear
Rapid Emergency Triage and Treatment System-paediatrics (RETTS-p)	General	Child	Emergency medical services	Sweden	Yes

Tool	Disease	Population	Setting	Location	Validity
Rapid team triage (Rapid team)	General	Unclear	Emergency department	Australia, Unclear	Yes
RAT decision-support app	Unclear	Unclear	Emergency department	 United Kingdom	Unclear
Resuscitation Management score (THERM)	Unclear	Adult	Emergency department	 United Kingdom	Yes
RISKINDEX	General	Unclear	Emergency department	Netherlands	Yes
Score for Emergency Risk Prediction (SERP)	General	Adult	Emergency department	Korea	Yes
Senior Streaming Assessment Further Evaluation after Triage (SAFE-T) Zone	General	Unclear	Emergency department	Unclear	No

Tool	Disease	Population	Setting	Location	Validity
Sequential Organ Failure Assessment (SOFA) score	Hepatic Portal Venous Gas, Presumed Infection, Sepsis, Unspecified	Adult, Unclear	Emergency department	 Australia, India, Italy, Taiwan, United Kingdom	Yes, Unclear
Shock Index (SI)	Diabetes, Hypertension, Ruptured Abdominal Aortic Aneurysm (Raaa), Gastrointestinal Bleeding	Adult, Older Adult, Unclear	Emergency department	Denmark, Turkey, Unclear	Yes, Unclear
Simple Prognostic Score (SPS)	General	Unclear	Emergency department	Switzerland	Yes
Simple Triage and Rapid Treatment (START)	General,	Unclear	Emergency department, Pre-hospital setting	United States, Unclear	Yes
Simplified Acute Physiology Score II (SAPS II)	Hepatic Portal Venous Gas, Presumed Infection, Unspecified	Adult, Unclear	Emergency department	Australia, Italy, Korea, Taiwan	Yes, Unclear

Tool	Disease	Population	Setting	Location	Validity
Simplified Acute Physiology Score III (SAPS III)	Unspecified	Adult	Emergency department	Korea	Yes
Soft tissue oxygen saturation (Sto2) measurement	Unspecified	Adult	Emergency department	Unclear	Unclear
Soterion Rapid Triage System (SRTS)	General	Child	Emergency department	International	Yes
South African Triage Scale (SATS)	General	Child, Healthcare Provider	Emergency department, Emergency medical services, Pre-hospital setting	International	Yes
Streaming	General, Trauma	Adult, Healthcare Provider, Unclear	Emergency department	 Australia, Netherlands, United Kingdom, Unclear	Yes
Sydney Triage to Admission Risk Tool (START)	General	Unclear	Emergency department	Australia	Yes

Tool	Disease	Population	Setting	Location	Validity
Symptom Assessment Application (SAA)	General	Unclear	Emergency department	Germany	Yes
Taiwan Prehospital Triage System (TPTS)	General	Unclear	Emergency department	Taiwan	No
Taiwan Triage and Acuity Scale (TTAS)	General	Healthcare Provider, Unclear	Emergency department	Taiwan	Yes
Think Frailty	Unspecified	Older Adult	Emergency department	Ireland	Yes
Three-level triage scale (TLTS)	General	Healthcare Provider	Emergency department	Hong Kong	Yes
Triage Information Mortality Model (TIMM)	General	Unclear	Emergency department	Unclear	Yes
Triage level (TL)	Asthma	Child	Emergency department	Spain	Unclear
Triage Quality Assessment Software (TQAS)	General	Healthcare Provider	Emergency department	Australia	Yes
Triage Risk Stratification Tool (TRST)	General	Older Adult, Unclear	Emergency department, Unclear	Italy, International	Yes

Tool	Disease	Population	Setting	Location	Validity
Triage scoring system (TSS)	General	Unclear	Emergency department	Unclear	Yes
Triage Sieve	Trauma	Unclear	Emergency department	Unclear	Unclear
Triage through telemedicine	Unspecified	Child	Emergency department	Germany	No
TriAGe+ (diagnostic score)	Stroke	Adult	Emergency department	Japan	No
Vitalpac Early Warning Score (VEWS)	General	Adult	Ambulance services	Spain	Yes
VitalPAC EWS (ViEWS)	Unspecified	Adult	Emergency department	Korea	Yes
West coast System for Triage (WEST)	General	Adult	Ambulance services, Emergency department	Sweden	Yes

How is effectiveness measured?

The ways in which the effectiveness of the tools has been assessed is summarised in *Table 3*. This table summarises whether the validation of the tool was based on assessing the area under the receiver-operator curve (AUC), inter-rater reliability, sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), ease of use or undertriage and overtriage rates (mistriage).

Please note that the data in *Table 3* is based on the information in the abstracts indexed in the Evidence Map, and not on the details from the full-text publications.

The citations for the publications reporting on the effectiveness of acuity assessment tools is reported in the *Appendix 5: Citations of studies reporting on how effectiveness of tools has been assessed.*

Table 3 Assessment methods of acuity assessment tools

Tool	Validity (unspecified)	Accuracy (including AUC)	Inter-rater reliability	Sensitivity	Specificity	PPV	NPV	Ease of use	Mistriage
Algorithmic		x							
Ambulatory Score (Ambs)						x			
Australasian Triage Scale (ATS)		x	x					x	
Canadian Triage and Acuity Scale (CTAS)		x	x	x	x				x
Clinical Decision Support System (CDSS)	x								
Danish Emergency Process Triage (DEPT)			x						
Deep-learning-based Triage and Acuity Score (DTAS)	x								
Echelle Liegeoise d'Index de Severite a l'Admission (ELISA)	x								
Electronic Canadian Triage and Acuity Scale (eCTAS)								x	
Electronic patient self-triage	x		x	x					x
Emergency Department Triage Early Warning Score (TREWS)	x	x	x						
Emergency Severity Index (ESI)	x	x	x	x	x			x	x
Expert practitioner		x		x	x				
Japanese Triage and Acuity Scale (JTAS)		x	x	x					
Korean Triage and Acuity Scale (KTAS)		x							x
Machine-learning risk prediction models (AI models)		x		x	x	x	x	x	

Tool	Validity (unspecified)	Accuracy (including AUC)	Inter-rater reliability	Sensitivity	Specificity	PPV	NPV	Ease of use	Mistriage
Manchester Triage System (MTS)		x		x	x				
Medical Priority Dispatch System (MPDS)				x					
Modified Early Warning Score (MEWS)		x							
Modified Japanese Triage and Acuity Scale (mJTAS)	x								
Modified Pediatric Early Warning Score (mPEWS)	x			x	x				
Modified Rapid Emergency Medicine Score (mREMS)		x							
National Early Warning Score (NEWS)		x							
National Early Warning Score 2 (NEWS2)		x		x	x				
Netherlands Triage System (NTS)		x	x						
Paediatric Observation Priority Score (POPS)			x						
Paediatric Taiwan Triage and Acuity System (Ped-TTAS)		x	x						
Paediatric Taiwan Triage System (Ped-TTS)		x							
Paper-based triage system (Paper-based)								x	
Paramedic Pathfinder (PP)									x
Pediatric Assessment Triangle (PAT)		x	x						

Tool	Validity (unspecified)	Accuracy (including AUC)	Inter-rater reliability	Sensitivity	Specificity	PPV	NPV	Ease of use	Mistriage
Pediatric Canadian Triage and Acuity Scale (PedCTAS)			x	x	x				
Pediatric Early Warning Score (PEWS)		x	x	x	x				
Pediatric Sequential Organ Failure Assessment (pSOFA) score				x	x		x		
Prehospital National Early Warning Score (Ph-ViEWS)		x							
Prehospital National Early Warning Score 2 Lactate (PreNEWS2-L)						x	x		
Princess Marina Triage Scale (PMTS)	x								
Quick Sequential Organ Failure Assessment (qSOFA) score		x							
Quick-look triage approach (QLT)			x						
Ramathibodi Triage System (RTS)			x	x	x				
Rapid Emergency Medicine Score (REMS)		x							
Rapid Emergency Triage and Treatment System (RETTS)	x								
Rapid Emergency Triage and Treatment System - Hospital Unit West (RETTS-HEV)	x								
RISKINDEX		x							
Score for Emergency Risk Prediction (SERP)		x							
Simple Prognostic Score (SPS)			x						

Tool	Validity (unspecified)	Accuracy (including AUC)	Inter-rater reliability	Sensitivity	Specificity	PPV	NPV	Ease of use	Mistriage
Simple Triage and Rapid Treatment (START)		x							
Soterion Rapid Triage System (SRTS)	x								
South African Triage Scale (SATS)	x								
Streaming			x			x			
Sydney Triage to Admission Risk Tool (START)	x								
Taiwan Triage and Acuity Scale (TTAS)		x							
Three-level triage scale (TLTS, modified ATS)			x	x	x	x	x		x
Triage Risk Stratification Tool (TRST)				x	x				
Vitalpac Early Warning Score (VEWS)		x							
WEst coast System for Triage (WEST)									x

What outcomes are measured?

The outcomes that have been used to assess the effectiveness of acuity assessment tools are summarised below in *Table 4*. This table focuses on short-term outcomes, grouped into outcomes related to admission (to hospital or to intensive care units (ICU)), mortality, resource use and costs, and other outcomes. Please note that the data in Table 4 is based on the information from the abstracts of publications that have been indexed in the Evidence Map, not the full-text publications.

The citations of publications included in *Table 4* are reported in *Appendix 6: Citations of studies reporting on outcome measures used to assess effectiveness of acuity assessment tools*.

Table 4 Outcomes used to assess performance of acuity assessment tools

Tool	Admission	Mortality within 48H	Resource use and cost	Other outcomes
Algorithmic				Implementation Acuity assessment time
Australasian Triage Scale (ATS)	Admission to hospital			Implementation Length of stay in ED Rate of use Time to physician
Canadian Triage and Acuity Scale (CTAS)	Admission to hospital			Implementation Patient satisfaction Time to treatment
Clinical Decision Support System (CDSS)	Admission to hospital			Return to ED Unexpected return to ED within 7 days
Danish Emergency Process Triage (DEPT)		24-H mortality		
Dynamic Grouping and Prioritization (DGP) algorithm				Length of stay Length of stay in ED Time to treatment
Electronic Canadian Triage and Acuity Scale (eCTAS)				ED workflow
Electronic patient self-triage	Admission to hospital			
Emergency Department Triage Early Warning Score (TREWS)		24-H mortality 48-H mortality		72-H mortality Mortality in hospital

Tool	Admission	Mortality within 48H	Resource use and cost	Other outcomes
Emergency Severity Index (ESI)	Admission to hospital Admission to ICU		Resource use	Clinical outcomes Did-not-wait rate ED workflow Implementation Length of stay Length of stay in ED Mortality in hospital 7-day mortality 30-day mortality 1-year mortality Rate of use Provider satisfaction Time to treatment Acuity assessment time Views (qualitative)
Expert practitioner	Admission to hospital			Implementation Acuity assessment time
Hillerod Acute Process Triage (HAPT) system	Admission to ICU			Mortality in hospital
Illness Rating Score (IRS)	Admission to hospital			
Japanese Triage and Acuity Scale (JTAS)	Admission to hospital Admission to ICU			Door-to-triage time Implementation Length of stay in ED Safety Time to physician Time to treatment Acuity assessment time
Korean Triage and Acuity Scale (KTAS)	Admission to hospital			Length of stay Length of stay in ED 39-day mortality Mortality in hospital

Tool	Admission	Mortality within 48H	Resource use and cost	Other outcomes
Machine-learning risk prediction models (AI models)	Admission to hospital Admission to ICU			Clinical outcomes Length of stay in ED 30-day mortality 31-day mortality Mortality in hospital Provider satisfaction
Manchester Triage System (MTS)	Admission to hospital Admission to ICU		Resource use	Implementation Length of stay Length of stay in ED Mortality in hospital Short-term mortality Safety Time to treatment Acuity assessment time
Modified Early Warning Score (MEWS)	Admission to hospital Admission to ICU			Length of stay Length of stay in ED 30-day mortality Mortality in hospital Rate of use
Modified Japanese Triage and Acuity Scale (mJTAS)	Admission to hospital			Length of stay Mortality in hospital
Modified Pediatric Early Warning Score (mPEWS)	Admission to ICU			
Modified Rapid Emergency Medicine Score (mREMS)		24-H mortality 48-H mortality		72-H mortality 7-day mortality
National Early Warning Score (NEWS)				30-day mortality Mortality in hospital
National Early Warning Score 2 (NEWS2)	Admission to ICU	24-H mortality 48-H mortality		72-H mortality 7-day mortality Mortality in hospital
Netherlands Triage System (NTS)	Admission to hospital			30-day mortality

Tool	Admission	Mortality within 48H	Resource use and cost	Other outcomes
Paediatric Taiwan Triage and Acuity System (Ped-TTAS)	Admission to hospital		Resource use	
Paediatric Taiwan Triage System (Ped-TTS)	Admission to hospital		Resource use	
Paper-based triage system (Paper-based)				ED workflow
Paramedic Pathfinder (PP)				
Pediatric Assessment Triangle (PAT)				Safety
Pediatric Canadian Triage and Acuity Scale (PedCTAS)	Admission to hospital			Clinical outcomes
Pediatric Early Warning Score (PEWS)	Admission to hospital			implementation
Pediatric Sequential Organ Failure Assessment (pSOFA) score				Mortality in hospital
Pivot triage process (Pivot)				Did-not-wait rate ED workflow Implementation Length of stay in ED Time to physician
Prehospital National Early Warning Score 2 Lactate (PreNEWS2-L)		48-H mortality		7-day mortality 30-day mortality
Princess Marina Triage Scale (PMTS)	Admission to hospital			
Quick Sequential Organ Failure Assessment (qSOFA) score	Admission to ICU			Mortality in ICU
Quick-look triage approach (QLT)		48-H mortality		30-day mortality Rate of use Views (qualitative)
Ramathibodi Triage System (RTS)	Admission to hospital			
Rapid Emergency Medicine Score (REMS)	Admission to hospital Admission to ICU			Mortality in hospital
Rapid Emergency Triage and Treatment System (RETTS)	Admission to hospital			72-H mortality Rate of use
Rapid Emergency Triage and Treatment System - Hospital Unit West (RETTS-HEV)	Admission to hospital			Length of stay Mortality

Tool	Admission	Mortality within 48H	Resource use and cost	Other outcomes
Rapid Emergency Triage and Treatment System-paediatrics (RETTS-p)				Clinical outcomes
Rapid team triage (Rapid team)				implementation
RISKINDEX				31-day mortality
Score for Emergency Risk Prediction (SERP)				30-day mortality Mortality in hospital
Secondary telephone triage (Phone)				Safety
Senior Streaming Assessment Further Evaluation after Triage (SAFE-T) Zone				Did-not-wait rate Length of stay in ED Off-stretcher time Time to physician
Simple Prognostic Score (SPS)				7-day mortality 30-day mortality 1-year mortality
Simple Triage and Rapid Treatment (START)	Admission to hospital			Acuity assessment time
Soterion Rapid Triage System (SRTS)	Admission to hospital			
South African Triage Scale (SATS)	Admission to hospital			
Streaming	Admission to hospital Admission to ICU		Resource use	Did-not-wait rate ED workflow Implementation Length of stay Length of stay in ED Off-stretcher time Time to physician Time to treatment
Symptom Assessment Application (SAA)				Length of stay in ED Time to treatment
Taiwan Prehospital Triage System (TPTS)			Resource use	Clinical outcomes
Taiwan Triage and Acuity Scale (TTAS)	Admission to hospital		Resource use	Clinical outcomes

Tool	Admission	Mortality within 48H	Resource use and cost	Other outcomes
Telemedical physician triage (Telemedicine)				Implementation Length of stay in ED Safety Patient satisfaction Provider satisfaction Time to physician Acuity assessment time
Three-level triage scale (TLTS, modified ATS)	Admission to hospital			
Triage Information Mortality Model (TIMM)				Mortality in hospital
Triage Risk Stratification Tool (TRST)	Admission to hospital			Return to ED
Vitalpac Early Warning Score (VEWS)		24-H mortality 48-H mortality		72-H mortality 7-day mortality
WEst coast System for Triage (WEST)	Admission to hospital			

5. What evidence is there on the effectiveness of these models, systems, and tools?

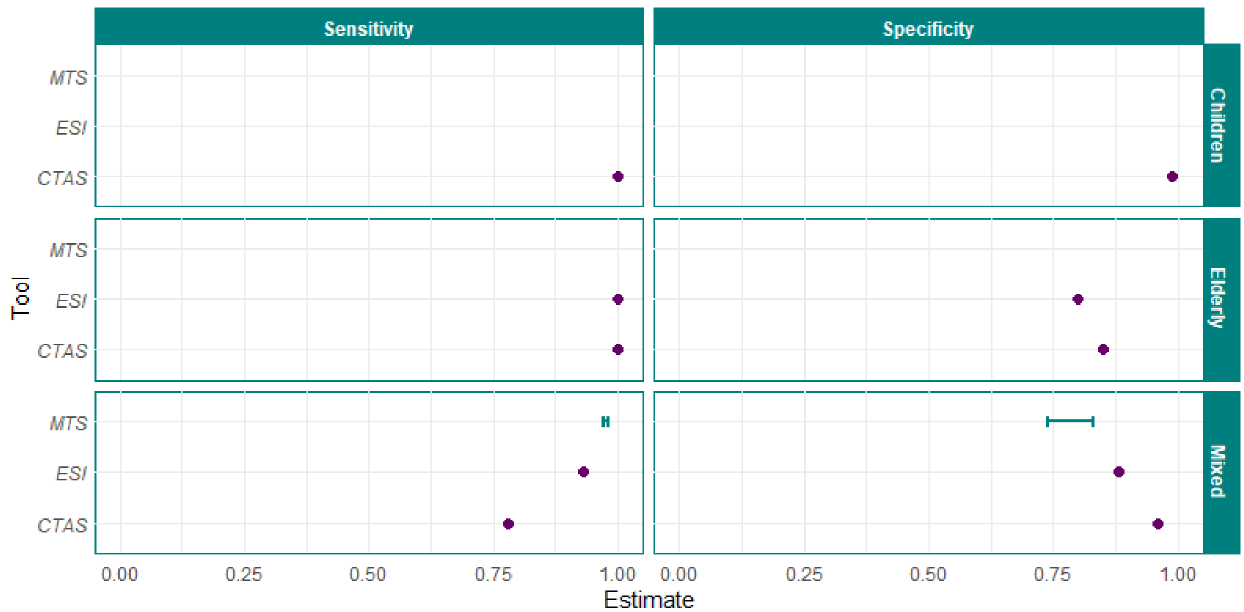
A total of 40 studies were shortlisted from the Evidence Map for full-text review, of which 16 reported useful data on the effectiveness of one or more acuity assessment tools in a relevant population and context and have been summarised here.

Data from the existing systematic reviews that have compared accuracy of acuity assessment tools has shown that their sensitivity, specificity, and other measures of effectiveness vary across studies for the same tool, therefore the context in which the tool is used clearly affects its accuracy. Several studies reported on undertriage and overtriage rates, although these were usually not defined, so it is unclear whether these rates are comparable across studies.

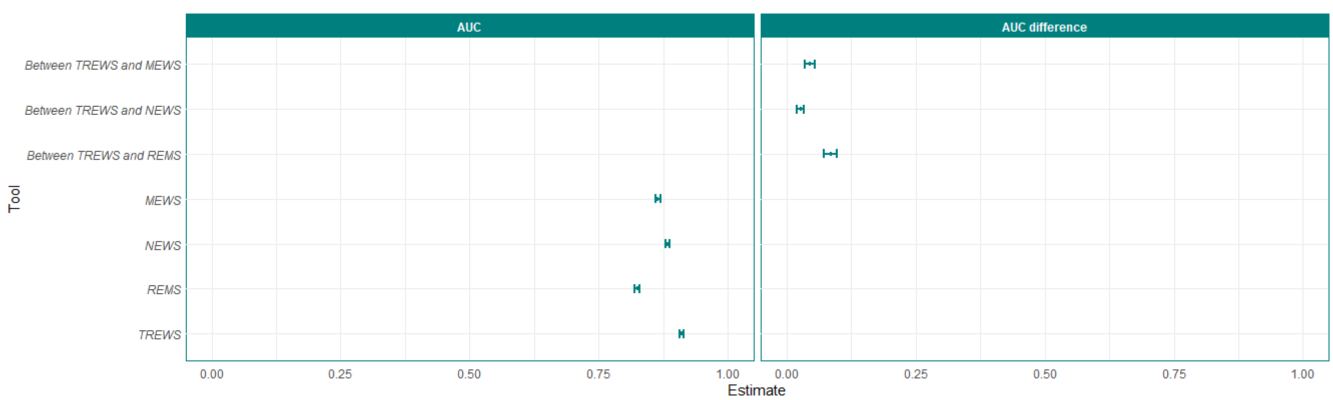
Studies that have reported inter-rater reliability have generally found good reliability for the tools assessed within the same professional group (e.g., physicians, nurses) but less good reliability comparing scores from physicians and nurses. Each of these studies has been summarised in more detail in the following sections of this report.

The following charts display the relevant and comparable data from these 40 studies for test performance. These charts are intended to give an overview of the comparative accuracy of each tool, but they have not been based on a formal statistical comparison or meta-analysis where study heterogeneity has been taken into account. As such, they are only indicative of performance. Despite this caveat, there does not appear to be any one tool with a substantially better performance than the others for predicting important clinical outcomes.

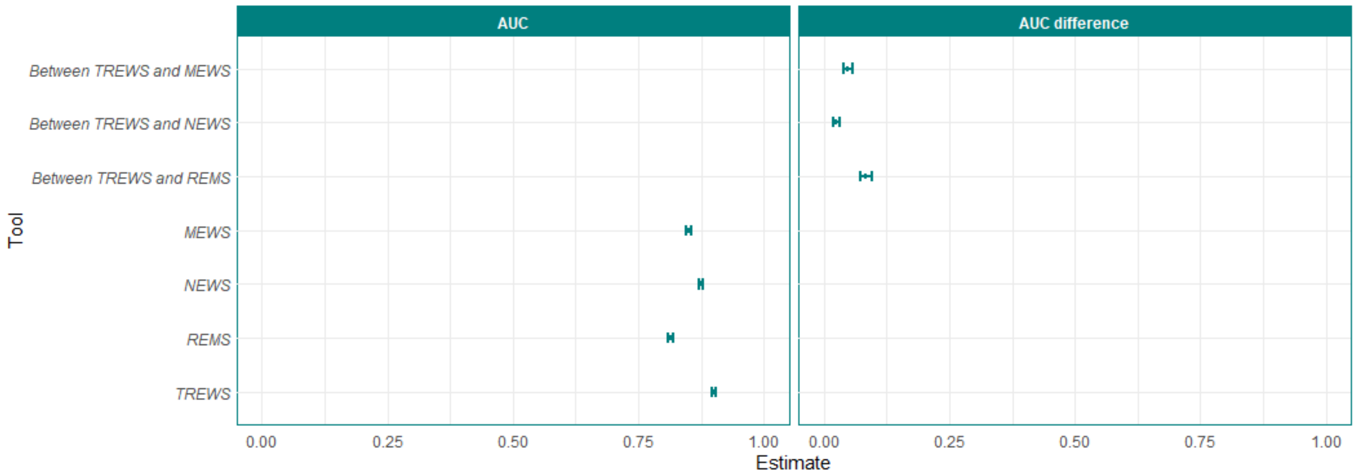
Mortality in the ED (Hinson et al. (2019)



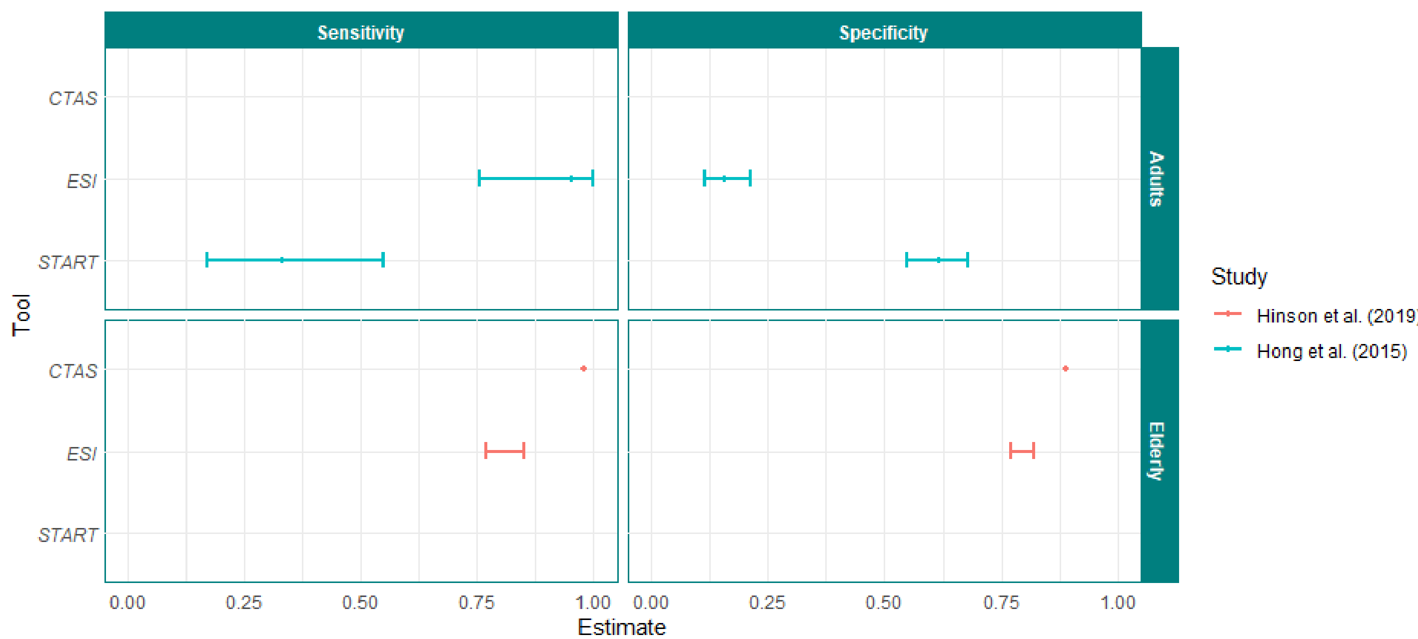
Mortality within 24 hours (Lee et al. 2020)



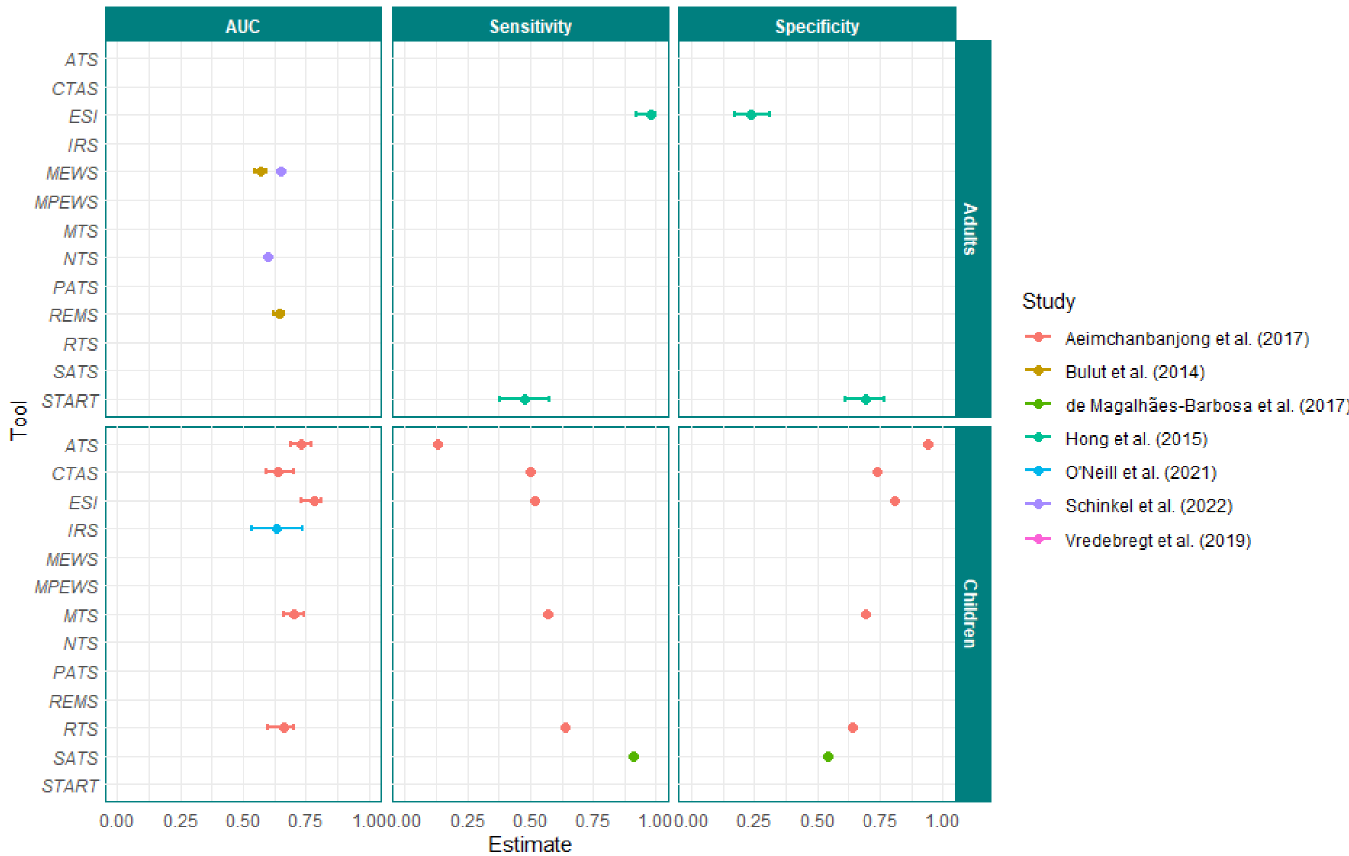
Mortality within 48 hours (Lee et al. 2020)



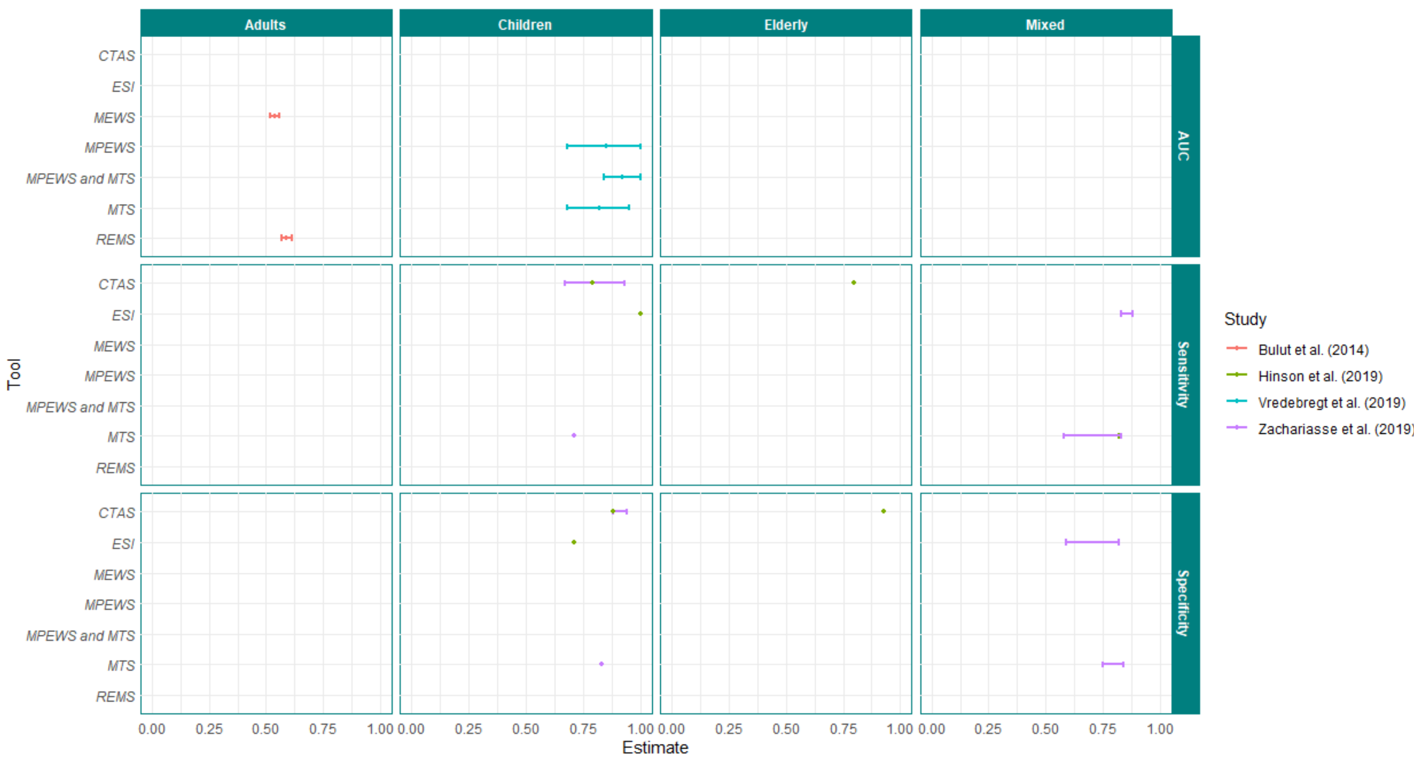
Need for emergency or life-saving intervention



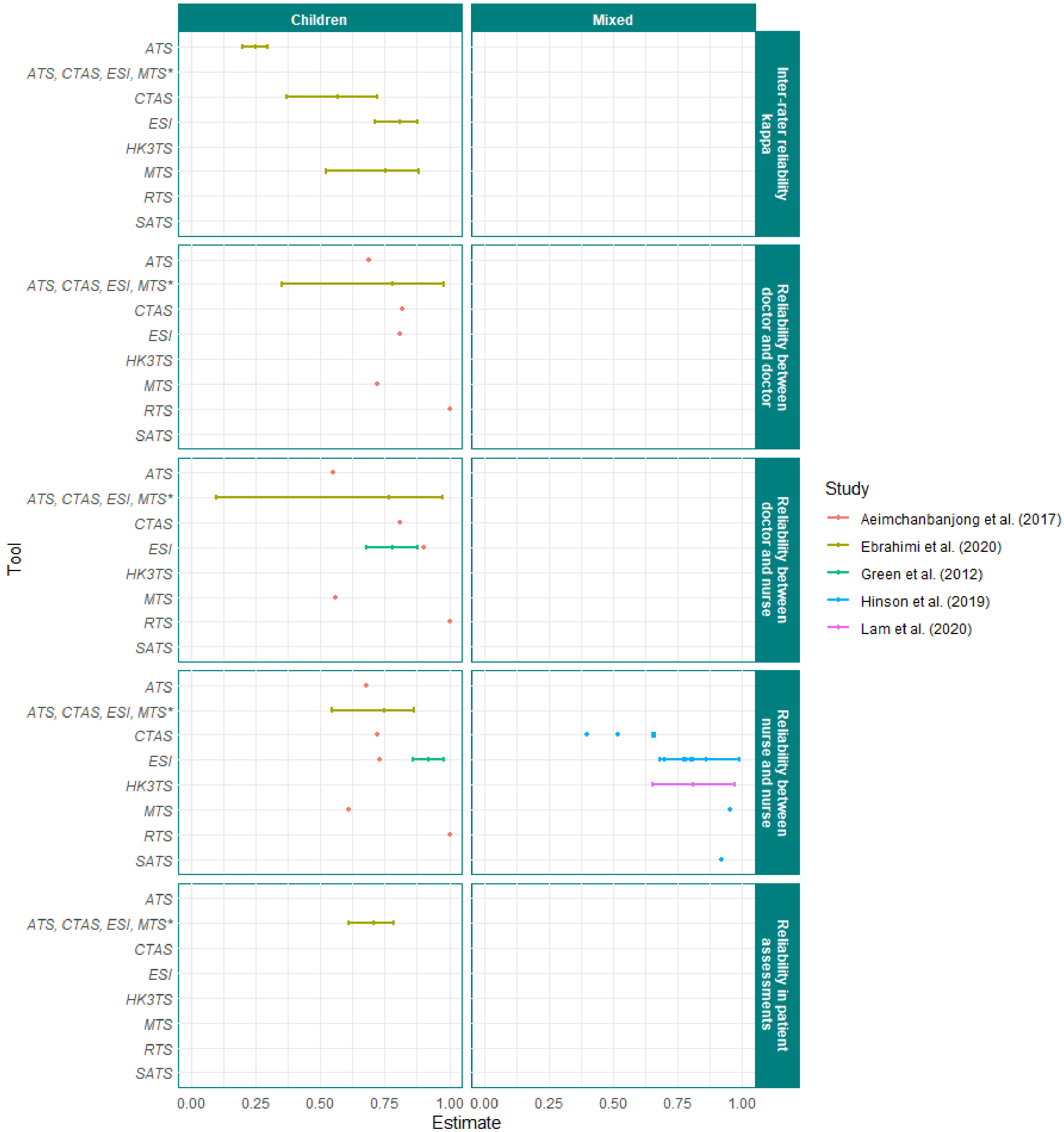
Hospital admission



ICU admission



Inter-rater reliability (mixed weighted, unweighted, linear and quadratic kappa scores)



Studies comparing the performance of different tools

Aeimchanbanjong et al. (2017) found that the Emergency Severity Index (ESI) had the highest AUC for predicting hospital admission in children up to age 15 years in Thailand in 2015 (AUC 0.78), followed by 0.73 for the Australasian Triage System (ATS), 0.70 for the Manchester Triage System (MTS), 0.66 for the Ramathibodi Triage System (RTS) and 0.64 for the Canadian Triage and Acuity Scale (CTAS). The authors concluded that ESI had the best validity of the 5 tools in this population.

Bulut et al. (2014) found that the Rapid Emergency Medicine Score (REMS) was significantly more accurate at predicting admission to hospital, admission to ICU and in-hospital mortality than the Modified Early Warning Score (MEWS) in 2,000 adults attending ED in Turkey in 2011-2012. A cut-off score for MEWS of 5 was able to discriminate between patients likely to die in hospital, with a risk of death 3.837 times higher (95%CI 2.358 to 6.243, $p<0.001$) for those with a score ≥5 compared with <5. A cut-off score for REMS of 6 was also able to discriminate between patients likely to die in hospital, with a risk of death 2.923 times higher (95%CI 0.026 to 4.217, $p<0.001$) than those with a score <6.

De Magalhaes et al (2017) synthesised relevant data on the accuracy of the MTS and modified MTS compared with an expert-derived reference standard from 7 studies, and data on South African Triage Scale (SATS), Princess Marina Hospital Triage Scale (PATS) and ESI v4 from 1 study each, identified via a systematic review. The original MTS had a moderate sensitivity of 63% that led to overtriage in 47% and undertriage in 15%. A modified version of the MTS had similar sensitivity but higher specificity, which was associated with a reduced overtriage rate (47%) but similar undertriage rates (15%). The SATS had a positive predictive value of only 37.5% and negative predictive value of 95.3%, leading to overtriage in 45.5% of patients and undertriage in 9%. The PATS had lower overtriage rates (28.8%) but higher undertriage rates (21.9%). The ESI had the smallest rates of overtriage (16%) and undertriage (11%). However, the accuracy of the ESI varied by geographical location, with heterogeneous outcomes particularly seen outside of North America. Comparable accuracy data was not reported reliably for the pediatric CTAS. Undertriage was defined as patients categorised as an ESI level 4 or 5 or PATS level 4 who consumed >2 resources or were admitted to hospital, and overtriage as patients categorised as ESI 1, 2 or 3 or PATS level 1 or 2 who were not admitted to hospital or consumed <2 resources.

Hinson et al (2019) conducted a meta-analysis of 50 studies comparing the validity of acuity assessment systems in a range of patient populations attending ED. Overall sensitivity and specificity was determined for each acuity assessment tool in each population for predicting a range of clinical outcomes. For ED and 1-day mortality, the sensitivity was highest for MTS and ESI in a general population, with high sensitivity also recorded for CTAS in children. Specificity was higher for CTAS and ESI than NTS in a general population. For ICU admission, sensitivity and specificity of MTS varied by study but was generally high in a general population, while ESI had very high sensitivity but relatively low specificity in children compared with CTAS and MTS.

Hong et al. (2015) compared the accuracy of the Simple Triage and Rapid Treatment (START) used by pre-hospital providers with the Emergency Severity Index (ESI) used by ED staff on 233 adults attending ED in the US in 2011. The sensitivity of START was substantially lower than ESI for predicting the presence of abnormal vital signs, need for emergency intervention and admission (33.3% to 51.0% with START vs 87.8% to 97.9% with ESI), but the specificity of START was substantially higher than ESI (61.6% to 69.3% with START vs 15.2% to 23.4% with ESI).

Lee et al. (2020) reported on the development and validation of the Triage in Emergency Department Early Warning Score (TREWS) to predict mortality within 24 and 48 hours among 81,520 adults attending ED in Korea in 2010 to 2017. In both the derivation group and the validation group, TREWS had a significantly higher AUC for 24-hour and 48-hour mortality than the National Early Warning Score (NEWS), Modified Early Warning Score (MEWS) and Rapid Emergency Medicine Score (REMS).

Schinkel et al. (2022) found that the Modified Early Warning Score (MEWS) was more accurate than the Netherlands Triage System, a modification of the Manchester Triage Scale, at predicting hospital admission among 12,317 adults presenting to ED in the Netherlands in 2018-2020. The AUC was 0.65 with MEWS and 0.60 with NTS ($p<0.001$). The study showed that early warning scores may be more accurate than complaint-based acuity assessment scales at predicting hospital admission and 30-day mortality.

Vredebregt et al. (2019) assessed the performance of the Modified Paediatric Early Warning Score (MPEWS) compared with the Manchester Triage System at predicting ICU admission in 2812 children under 16 years of age presenting at ED in the Netherlands in 2015-2016. At an optimal cut-off score of 5, the MPEWS had a sensitivity of 80% and specificity of 85%, with a PPV of 1.8% and NPV of 100%. At this threshold, the AUC for MPEWS was the same as that of the MTS. The MPEWS was not able to predict hospitalisation, however, with an AUC of 0.57.

Zachariasse et al. (2019) conducted a systematic review of 66 studies that compared the accuracy of the Canadian Triage And Acuity Scale (CTAS), the Emergency Severity Index (ESI) and the Manchester Triage System (MTS) to identify high-urgency patients requiring ICU admission and low-urgency patients who did not require hospital admission. Differences in outcome definitions and reference standards meant that no overall meta-analysis could be conducted. Although there were differences across studies in sensitivity and specificity for each tool, there were no clear differences between tools for identifying high-urgency and low-urgency patients.

Full details are provided in *Table 5*. Full citations are provided in

Appendix 4: Citations of studies reporting evidence on models/systems/tools. All the data on the performance of each tool are also summarised in *Appendix 8: Evidence on each model/system/tool*.

AUC: Area under the curve, AUROC: Area under the receiver operating characteristic curve, CI: Confidence Interval, ED: Emergency Department, LR (-): Negative Likelihood Ratio, LR (+): Positive Likelihood Ratio, NA: Not Applicable, NPV: Negative Predictive Value, PPV: Positive Predictive Value, ROC: Receiver operating characteristic curve

Table 5 Effectiveness of triage tools assessed in comparative studies

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
Aeimchanbanjong et al. (2017)	1041 children <15 years attending ED in Thailand in 2015	MTS ESI CTAS ATS RTS	Compared with clinical outcome	Ability to predict admission	MTS: 57% ESI: 52% CTAS: 50% ATS: 13% RTS: 64%	MTS: 69% ESI: 81% CTAS: 74% ATS: 94% RTS: 64%	NA	NA	**AUC of ROC** MTS: 0.70 (0.66 to 0.744) ESI: 0.78 (0.73 to 0.81) CTAS: 0.64 (0.59 to 0.70) ATS: 0.73 (0.69 to 0.77) RTS: 0.66 (0.60 to 0.70)
Bulut et al. (2014)	2000 adults attending EDs in Turkey in 2011-12	MEWS REMS	Compared with clinical outcome	Ability to predict admission	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.568 (0.546 to 0.590), p<0.001 REMS: 0.642 (0.621 to 0.663), p<0.001
				Ability to predict admission to intensive care unit (ICU)/high dependency	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.538 (0.516 to 0.560), p=0.009 REMS: 0.589 (0.567 to 0.611), p<0.001

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
				unit (HDU)					
				Ability to predict in-hospital mortality	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.630 (0.608 to 0.651), p<0.001 REMS: 0.707 (0.686 to 0.727), p<0.001
de Magalhães-Barbosa et al. (2017)	Systematic review of 25 studies with a total of 973,099 children attending EDs in 11 countries including Canada and England published in 2005-14	MTS (7 studies, N=65,022)	Expert-developed reference standard	Ability to detect high urgency	63%	78% to 79%	NA	LR (+): 3.0 LR (-): 0.47	Absolute agreement: 34% to 45% Overtriage: 40% to 54% Undertriage: 12% to 15%
				Percentage of undertriage in levels 1 and 2	NA	NA	NA	NA	Percentage of undertriage in levels 1 & 2: 2% Percentage of undertriage >1 category: 0.9% Percentage of serious under-triage according to experts: 0.65%
				Ability to detect	58% vs 74%	78% vs 75%	NA	LR (+): 2.6	Absolute agreement:

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
				high urgency in febrile patients with chronic disease vs without chronic disease				vs 1.1 LR (-): 0.71 vs 0.80	35% vs 30% Overtriage: 48% vs 59% Undertriage: 17% vs 11% Diagnostic OR of high urgency: 4.8 vs 8.7
			Compared with clinical outcome	Ability to detect serious bacterial infection	42%	69%	PPV: 14% NPV: 91%	LR (+): 1.35 LR (-): 0.84	AUC: 0.57
		Modified MTS (2 studies, N=71,635)	Expert-developed reference standard	Ability to detect high urgency	64%	87%	NA	NA	Absolute agreement: 37% Overtriage: 47% Undertriage: 15% Diagnostic OR of high urgency: 11.5
		SATS (1 study, N=2014)	Compared with clinical outcome	Ability to predict hospital admission	91%	54.5%	PPV: 37.5% NPV: 95.3%	NA	Overtriage: 45.5% Undertriage: 9%

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
		PATS (1 study, N=35,948)	Compared with clinical outcome	Association with hospital admission	NA	NA	NA	NA	Overtriage: 28.8% Undertriage: 21.9% (Overtriage: PATS level 1 or 2 not admitted to hospital, Under-triage: PATS level 4 admitted to hospital)
		ESI (4 studies, N=3,394)	Compared with clinical outcome	Association with hospital admission	NA	NA	NA	NA	Overtriage: 16% Undertriage: 11% (Overtriage: ESI level 1,2 or 3 who used <2 resources, or ESI level 1 not admitted to hospital. Under-triage: ESI level 4 or 5 who used ≥2 resources or admitted to hospital
Hinson et al. (2019)	Systematic review of 50 studies (1999-2017) with 50 to 549,351 patients attending EDs in	ATS CTAS ESI MTS	Compared with clinical outcome	ED Mortality	CTAS: 0.78 (General), 1.00 (Paediatric), 1.00 (Elderly)	CTAS: 0.96 (General), 0.99 (Paediatric), 0.85 (Elderly)	NA	NA	NA

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
	16 countries incl Canada & Australia	SATS			ESI: 0.93 (General), 1.00 (Elderly) MTS: 0.97 to 0.98 (General) ATS: 0.75 (Severe Sepsis)	ESI: 0.88 (General), 0.80 (Elderly) MTS: 0.74 to 0.83 (General) ATS: 0.59 (Severe Sepsis)			
			Compared with clinical outcome	In-Hospital Mortality	ATS: 0.34 (General) MTS: 0.39 to 0.69 (General), 0.73 (Pulmonary Embolism) CTAS: 0.64 (Elderly) ESI: 0.64 (Elderly)	ATS: 0.94 (General) MTS: 0.74 to 0.85 (General), 0.50 (Pulmonary Embolism) CTAS: 0.81 (Elderly) ESI: 0.81 (Elderly)	NA	NA	NA
			Compared with clinical outcome	1-Day Mortality	CTAS: 0.70 (Heart Failure)	CTAS: 0.57 (Heart Failure)	NA	NA	NA

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
			Compared with clinical outcome	ICU Admission	MTS: 0.58 to 0.82 (General), 0.71 (Paediatric) CTAS: 0.79 (Paediatric), 0.80 (Elderly), 0.63 (Heart Failure) ESI: 1.00 (Paediatric)	MTS: 0.75 to 0.84 (General), 0.83 (Paediatric) CTAS: 0.88 (Paediatric), 0.93 (Elderly), 0.59 (Heart Failure) ESI: 0.71 (Paediatric)	NA	NA	NA
			Compared with clinical outcome	Immediate Life-Saving Intervention	CTAS: 0.98 (Elderly) ESI: 0.77 to 0.85 (Elderly)	CTAS: 0.89 (Elderly) ESI: 0.77 to 0.82 (Elderly)	NA	NA	NA
			Compared with clinical outcome	Hospitalisation at High Acuity Level 1 or 2	ATS: 0.18 (General) CTAS: 0.18 to 0.44 (General), 0.09 to 0.45 (Paediatric), 0.28	ATS: 0.97 (General) CTAS: 0.80 to 0.98 (General), 0.91 to 0.99 (Paediatric), 0.96	NA	NA	NA

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
					(Elderly) ESI: 0.28 to 0.68 (General), 0.41 to 0.93 (Paediatric), 0.67 (Elderly) MTS: 0.37 to 0.59 (General), 0.70 (Paediatric)	(Elderly) ESI: 0.84 to 0.93 (General), 0.78 to 0.94 (Paediatric), 0.76 (Elderly) MTS: 0.78 to 0.93 (General), 0.70 (Paediatric)			
			Compared with clinical outcome	Hospitalisation at Mid-Acuity Level 1 through 3	ATS: 0.58 (General) CTAS: 0.69 to 0.85 (General), 0.55 to 0.91 (Paediatric), 0.92 (Elderly) ESI: 0.86 to 0.97 (General), 0.82 to 0.95	ATS: 0.81 (General) CTAS: 0.34 to 0.80 (General), 0.52 to 0.86 (Paediatric), 0.38 (Elderly) ESI: 0.54 to 0.67 (General), 0.59 to 0.68	NA	NA	NA

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
					(Paediatric), 0.98 (Elderly) MTS: 0.85 to 0.96 (General), 0.91 (Paediatric)	(Paediatric), 0.30 (Elderly) MTS: 0.25 to 0.54 (General), 0.44 (Paediatric)			
Hong et al. (2015)	233 adults attending ED in the United States in 2011	START by prehospital providers ESI by ED staff	Compared with clinical outcome	Presence of abnormal vital signs	START: 51.0% (37.5% to 64.4%) ESI: 87.8% (75.4% to 94.6%)	START: 65.8% (58.6% to 72.2%) ESI: 15.2% (10.7% to 21.2%)	NA	NA	NA
				Need for an emergent intervention	START: 33.3% (17.1% to 54.8%) ESI: 95.2% (75.6% to 99.9%)	START: 61.6% (54.9% to 67.9%) ESI: 15.6% (11.3% to 21.2%)	NA	NA	NA
				Admission status	START: 47.9% (38.2% to	START: 69.3% (61.2% to	NA	NA	NA

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
					57.8%) ESI: 97.9% (92.3% to 99.9%)	76.5%) ESI: 23.4% (17.0% to 31.2%)			
Lee et al. (2020)	81,520 adults attending ED in Korea in 2010-17	TREWS NEWS MEWS REMS	Compared with clinical outcome	Ability to predict mortality within 24 h (Derivation group)	NA	NA	NA	NA	**AUC of ROC** TREWS: 0.906 (0.903 to 0.908) NEWS: 0.878 (0.875 to 0.881) MEWS: 0.857 (0.854 to 0.860) REMS: 0.834 (0.831 to 0.837) **AUC difference** Between TREWS and NEWS: 0.028 (0.022 to 0.033), p<0.001 Between TREWS and MEWS: 0.049 (0.041 to 0.057), p<0.001 Between TREWS and REMS: 0.072 (0.063 to 0.080), p<0.001

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
				Ability to predict mortality within 24 h (Validation group)	NA	NA	NA	NA	**AUC of ROC** TREWS: 0.910 (0.907 to 0.914) NEWS: 0.884 (0.880 to 0.888) MEWS: 0.865 (0.861 to 0.869) REMS: 0.825 (0.820 to 0.829) **AUC difference** Between TREWS and NEWS: 0.027 (0.020 to 0.033), p<0.001 Between TREWS and MEWS: 0.045 (0.035 to 0.055), p<0.001 Between TREWS and REMS: 0.085 (0.072 to 0.098), p<0.001
				Ability to predict mortality within	NA	NA	NA	NA	**AUC of ROC** TREWS: 0.899 (0.895

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
				48 h (Validation group)					to 0.903) NEWS: 0.874 (0.870 to 0.878) MEWS: 0.851 (0.846 to 0.855) REMS: 0.815 (0.810 to 0.819) **AUC difference** Between TREWS and NEWS: 0.025 (0.018 to 0.031), p<0.001 Between TREWS and MEWS: 0.048 (0.039 to 0.058), p<0.001 Between TREWS and REMS: 0.084 (0.073 to 0.096), p<0.001
Schinkel et al. (2022)	12,317 adults attending ED in the Netherlands in 2018-20	NTS MEWS	Compared with clinical outcome	Ability to predict hospital admission	NA	NA	NA	NA	**AUC of ROC** NTS: 0.60 (0.60 to 0.61) MEWS: 0.65 (0.65 to 0.66), p<0.001

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
Vredebregt et al. (2019)	2812 children <16 years attending ED in the Netherlands in 2015-16	MPEWS MTS	Compared with clinical outcome	Ability to predict ICU admission	MPEWS ≥4: 80% (44% to 96%) MPEWS ≥5: 80% (44% to 96%) MPEWS ≥6: 70% (35% to 92%) MPEWS ≥7: 60% (27% to 86%)	MPEWS ≥4: 77% (75% to 78%) MPEWS ≥5: 85% (83% to 86%) MPEWS ≥6: 90% (88% to 91%) MPEWS ≥7: 94% (93% to 95%)	MPEWS ≥4: PPV: 1.2% (0.5% to 2.4%) NPV: 100% (99.6% to 100%) MPEWS ≥5: PPV: 1.8% (0.8% to 3.7%) NPV: 100% (99.7% to 100%) MPEWS ≥6: PPV: 2.3% (1.0% to 5.0%) NPV:	NA	**AUC of ROC** MPEWS ≥4: 0.78 (0.64 to 0.93), p=0.002 MPEWS ≥5: 0.82 (0.68 to 0.97), p<0.001 MPEWS ≥6: 0.80 (0.63 to 0.97), p=0.001 MPEWS ≥7: 0.77 (0.59 to 0.96), p=0.003 MPEWS (no cutoff): 0.85 (0.68 to 1.00), p<0.001 MTS (categorical): 0.82 (0.68 to 0.95), p<0.001 Model with MPEWS (no cutoff) and MTS: 0.92 (0.84 to 1.00), p<0.001 Model with MPEWS ≥5 and MTS: 0.89

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
							100% (99.6% to 100%) MPEWS ≥7: PPV: 3.5% (1.4% to 7.9%) NPV: 99.8% (99.6% to 100%)		(0.77 to 1.00), p<0.001
				Ability to predict hospitalization	NA	NA	NA	NA	**Maximum AUROC** MPEWS: 0.57 (0.55 to 0.59)
Zachariasse et al. (2019)	A systematic review and meta-analysis of 66 studies with a median sample size of 1496 in children, 1447 in adults and 929 in	CTAS ESI Manchester Triage System (MTS)	Compared with clinical outcome	Ability to identify high-urgency patients (ICU admission)	CTAS: 0.67 to 0.93 (children) ESI: 0.83 to 0.88 (adults/ unspecified) MTS : 0.71 (children),	CTAS: 0.88 to 0.94 (children) ESI: 0.59 to 0.82 (adults/ unspecified) MTS: 0.83 (children),	NA	NA	NA

Study	Population	Tool *(see Glossary)*	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
	elderly attending EDs in higher income countries published from 1980 to 2018				0.58 to 0.83 (adults/ unspecified)	0.75 to 0.84 (adults/ unspecified)			
				Ability to identify low-urgency patients (discharge home after the ED visit)	CTAS: 0.13 to 0.59 (children), 0.27 to 0.44 (adults/ unspecified) ESI: 0.41 to 0.85 (children), 0.08 to 0.65 (adults/ unspecified) MTS: 0.43 to 0.70 (children), 0.37 to 0.59 (adults/ unspecified)	CTAS: 0.74 to 0.96 (children), 0.80 to 0.92 (adults/ unspecified) ESI: 0.80 to 0.94 (children), 0.64 to 0.98 (adults/ unspecified) MTS: 0.69 to 0.86 (children), 0.78 to 0.93 (adults/ unspecified)	NA	NA	NA

Studies assessing inter-rater reliability

Aeimchanbanjong et al. (2017) found that when inter-rater reliability was assessed, the RTS had perfect agreement for agreements between doctor-doctor, nurse-nurse and doctor-nurse comparisons, followed by ESI and CTAS, with kappa scores between 0.72 and 0.9. Kappa scores were lowest for MTS and ATS, and kappa scores were lower for nurse-nurse and doctor-nurse agreements than doctor-doctor.

Ebrahimi et al. (2020) meta-analysed inter-rater reliability for the Australasian Triage Scale (ATS), the Emergency Severity Index (ESI), the Manchester Triage System (MTS), and the Pediatric Canadian Triage and Acuity Score (paedCTAS) when used in children in the ED. Pooled correlation coefficient was 0.677 across all tools, indicating substantial agreement across users, with correlation coefficients based on weighted kappa statistics highest for the ESI (0.810) then the MTS (0.755), followed by the CTAS (0.571) and was lowest for the ATS (0.250). Across all studies, the level of agreement was highest between physicians and experts (0.840), then physician-physician (0.782), and nurse-nurse (0.769) and was lowest, but still reasonable, between physicians and nurses (0.659).

Green et al. (2012) prospectively assessed inter-rater reliability of the Emergency Severity Index (ESI) v 4 when used to assess 100 children attending an ED at one hospital in the US. The kappa for inter-rater reliability was high between nurses (0.92) and was lower but still substantial when comparing nurses with physicians (0.78).

Hinson et al (2019) conducted a meta-analysis of 50 studies comparing acuity assessment systems in a range of patient populations attending ED. Inter-rater reliability, all assessed in nurses, varied considerably across studies for each tool and ranged from 0.4 to 0.84 for unweighted kappa and between 0.52 and 0.95 for weighted kappas.

Lam et al. (2020) assessed the reliability of the Hong Kong 3-level Triage Scale (HK3TS). There was good agreement between nurses and criterion standard, with a kappa of 0.76.

Lin et al. (2013) found the inter-rater reliability of the Canadian Triage Acuity Scale (CTAS) was very high when used in 37,416 patients triaged as CTAS level 5 across Eds in Canada in 2002-2009. Kappa scores were -0.9 for the nurse CTAS score and the original acuity assessment of level 5 in admitted patients, and agreement between nurses was 95.8%.

Ng et al. (2019) found that the inter-rater reliability of the Taiwan Triage and Acuity Scale (TTAS) was high between emergency medical technicians (EMTs) and triage registered nurses, with a weighted kappa of 0.825 when used to assess 493 adults attending ED in Taiwan in 2014.

AUC: Area under the curve, AUROC: Area under the receiver operating characteristic curve, CI: Confidence Interval, ED: Emergency Department, LR (-): Negative Likelihood Ratio, LR (+): Positive Likelihood Ratio, NA: Not Applicable, NPV: Negative Predictive Value, PPV: Positive Predictive Value, ROC: Receiver operating characteristic curve

Table 6 Inter-rater reliability of acuity assessment tools

Study	Population	Tool	Comparator	Outcome assessed	Other measure of effectiveness (95% CI)
Aeimchanbanjong et al. (2017)	1041 children <15 years attending ED in Thailand in 2015	MTS ESI Paediatric CTAS ATS RTS	Between rater	Reliability	**Reliability between doctor and doctor** MTS: κ 0.72 ESI: κ 0.81 CTAS: κ 0.818 ATS: κ 0.69 RTS: κ 1 **Reliability between nurse and nurse** MTS: κ 0.61 ESI: κ 0.73 CTAS: κ 0.72 ATS: κ 0.68 RTS: κ 1 **Reliability between doctor and nurse** MTS: κ 0.56 ESI: κ 0.9 CTAS: κ 0.81 ATS: κ 0.55 RTS: κ 1

Study	Population	Tool	Comparator	Outcome assessed	Other measure of effectiveness (95% CI)
Ebrahimi et al. (2020)	A meta-analytic review of 13 studies with a total of 29,094 children attending EDs in five countries (Australia, Canada, Iran, Netherlands and the USA) in 2002-15	ATS CTAS ESI MTS	Between rater	Reliability (based on weighted kappa)	**Reliability of paediatric triage scales (pooled correlation coefficients):** ATS: 0.25 (0.202 to 0.297) CTAS: 0.571 (0.372 to 0.720) ESI: 0.810 (0.711 to 0.877) MTS: 0.755 (0.522 to 0.883) **Reliability among raters across all tools:** Nurse-nurse: 0.747 (0.546 to 0.866) Nurse-physician: 0.769 (0.100 to 0.973) Nurse-expert: 0.659 (0.574 to 0.729) Physician-physician: 0.782 (0.35 to 0.978) Physician-expert raters: 0.840 (0.813 to 0.863) **Reliability in different scenarios** Assessments of actual patients: 0.709 (0.609 to 0.786) Paper-based scenarios: 0.740 (0.608 to 0.832) **Overall pooled coefficient** Fixed-effects model: 0.677 (0.671 to 0.683) Random-effects model: 0.723 (0.648 to 0.784)
Green et al. (2012) .	100 children attending a paediatric ED in the United	ESI	Between rater	Reliability	Reliability among nurses: k 0.92 (0.86 to 0.98), intraclass correlation coefficient 0.96 (0.95 to 0.97), *P*<0.001 Reliability between nurses and physicians: k 0.78 (0.68 to 0.88), intraclass correlation coefficient 0.91 (0.87 to 0.94),

Study	Population	Tool	Comparator	Outcome assessed	Other measure of effectiveness (95% CI)
	States in 2010				*P*<0.001
Hinson et al. (2019)	A systematic review of 50 studies with a range of 50 to 549,351 patients attending EDs in 16 countries including Canada and Australia published between 1999 to 2017	ATS CTAS ESI MTS SATS	Between rater	Reliability (based on unweighted kappa)	**Reliability in patient encounters (nurse)** CTAS: 0.40 **Reliability in paper scenarios (nurse)** ATS: 0.41 ESI: 0.46 MTS: 0.76 SATS: 0.55
			Criterion standard	Reliability (based on unweighted kappa)	**Reliability in patient encounters (nurse)** ESI: 0.70 to 0.77 **Reliability in paper scenarios (nurse)** ATS: 0.43 CTAS: 0.46 ESI: 0.43 MTS: 0.48 to 0.84
			Between rater	Reliability (based on weighted kappa: linear or quadratic)	**Reliability in patient encounters (nurse)** CTAS: 0.52 (linear), 0.65 to 0.66 (quadratic) ESI: 0.78 (unknown) MTS: 0.95 (unknown)

Study	Population	Tool	Comparator	Outcome assessed	Other measure of effectiveness (95% CI)
					<u>Reliability in paper scenarios (nurse)</u> CTAS: 0.70 (linear), 0.79 to 0.87 (quadratic) ESI: 0.73 (quadratic), 0.76 to 0.80 (unknown) MTS: 0.82 (quadratic), 0.60 (unknown) SATS: 0.65 (linear), 0.77 (quadratic)
			Criterion standard	Reliability (based on weighted kappa: linear or quadratic)	**<u>Reliability in patient encounters (nurse)</u>** ESI: 0.80 (linear), 0.81 to 0.86 (quadratic), 0.68 to 0.99 (unknown) SATS: 0.92 (quadratic) **<u>Reliability in paper scenarios (nurse)</u>** CTAS: 0.71 (unknown) ESI: 0.71 (quadratic) MTS: 0.71 (linear), 0.62 to 0.87 (quadratic)
Lam et al. (2020)	151 patients (104 adults and 47 children) attending ED in Hong Kong in 2019	HK3TS	Criterion standard	Reliability (based on quadratic-weighted kappa)	Reliability between the acuity assessment nurse and criterion standard (95% CI): k 0.76 (0.60 to 0.92), p<0.001
			Between rater	Reliability (based on quadratic-weighted kappa)	Reliability across nurses (95%CI): k 0.81 (0.65 to 0.97), p<0.001
Lin et al. (2013)	37,416 patients assessed as CTAS level 5 at	CTAS	Between rater	Reliability	Reliability between nurse CTAS assignments and the original acuity assessment assignment of CTAS level 5

Study	Population	Tool	Comparator	Outcome assessed	Other measure of effectiveness (95% CI)
	EDs in Canada in 2002-09				for admitted patients (95% CI): κ -0.9 (-0.96 to -0.84) Reliability among nurses: 95.8%
Ng et al. (2019)	493 adults in the validation of acuity assessment scores in the field and 145 adults for inter-rater evaluation in the ED in Taiwan in 2014	TTAS TPTS	Between rater	Reliability (based on weighted kappa)	Reliability between emergency medical technicians and acuity assessment registered nurses: κ 0.825 (0.750 to 0.900)

AUC: Area under the curve, AUROC: Area under the receiver operating characteristic curve, CI: Confidence Interval, ED: Emergency Department, LR (-): Negative Likelihood Ratio, LR (+): Positive Likelihood Ratio, NA: Not Applicable, NPV: Negative Predictive Value, PPV: Positive Predictive Value, ROC: Receiver operating characteristic curve

Studies assessing performance of one tool

Three studies assessed the performance of just one tool. These were all small studies from a single centre, and only one (Lam 2020) reported on the use of an actual tool, the others assessing an illness rating analogue scale (O'Neill 2021) or expert "gut feelings" (Wiswell 2013).

Lam et al. (2020) assessed the performance of the Hong Kong 3-level Triage Scale (HK3TS) at predicting the need for early medical attention among 151 patients attending ED in Hong Kong in 2019. The sensitivity was 68.2% and specificity was 99.2%, with PPV of 93.8% and NPV of 94.8%. Overtriage and undertriage rates were low, at 0.7% and 4.6% respectively.

O'Neill et al. (2021) assessed the performance of a 2-item illness rating scale (IRS) to predict hospital admission among 141 children attending ED in the US with an ESI score of 2 or 3. On a visual analogue scale assessing how ill the patient appears, from 0 (totally well) to 10 (critically ill), a cut-off of 5 or more would correctly predict discharge from the ED without needing admission at least 72% of the time. The maximum number of patients correctly classified was 67% across all cut-off points.

Wiswell et al. (2013) assessed the ability of emergency physicians to gauge whether patients needed hospital or ICU admission or were sick versus not sick, based on their initial "gut feelings" when assessing 178 patients attending ED in the USA. Physicians overall predicted hospital admission correctly for 77% of observations and classified patient acuity correctly in 82% of observations. Sensitivity and specificity were generally higher for more experienced Attending physicians than Residents who were still in training for predicting hospital admission, but the differences were not statistically significant.

Table 7 Effectiveness of acuity assessment tools from non-comparative studies

Study	Population	Tool	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
Lam et al. (2020)	151 patients (104 adults and 47 children) attending ED in Hong Kong in 2019	HK3TS	Compared with clinical outcome	Ability to identify patients who required earlier medical attention	68.2% (45.1% to 86.1%)	99.2% (95.8% to 100%)	PPV: 93.8% (67.6% to 99.1%) NPV: 94.8% (90.8% to 97.1%)	NA	Overtriage rate: 0.7% Undertriage rate: 4.6%
O'Neill et al. (2021)	141 children attending a paediatric ED with medical complaints and Emergency Severity Index triage levels of 2 and 3 in the United States in 2019	Illness rating score (IRS)	Compared with clinical outcome	Ability to predict admission	IRS >1: 88% IRS >2: 72% IRS >3: 65% IRS >4: 58% IRS >5: 49% IRS >6: 31% IRS >7: 19% IRS >8: 4%	IRS >1: 12% IRS >2: 36% IRS >3: 57% IRS >4: 71% IRS >5: 76% IRS >6: 87% IRS >7: 95% IRS >8: 100%	IRS >1: PPV: 36% NPV: 65% IRS >2: PPV: 39% NPV: 70% IRS >3: PPV: 46% NPV: 74% IRS >4: PPV: 54% NPV: 75% IRS >5:	NA	AUC of ROC: 0.635 (0.534 to 0.737) **% Correct Classification** IRS >1: 40% IRS >2: 50% IRS >3: 60% IRS >4: 67% IRS >5: 66% IRS >6: 67% IRS >7: 67% IRS >8: 65%

Study	Population	Tool	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
							PPV: 53% NPV: 72% IRS >6: PPV: 57% NPV: 69% IRS >7: PPV: 67% NPV: 67% IRS >8: PPV: 100% NPV: 65%		
Wiswell et al. (2013)	178 adults (with a total of 266 observations) attending ED in the United States (data collection period unclear, published in 2013	Expert practitioner: emergency physicians (attending physicians and residents) using system 1 ("gut feeling") diagnostic reasoning to categorise patients as sick vs not sick	Compared with clinical outcome	Ability to predict disposition (discharge home vs hospital admission)	All physicians: 87.7% (81.4% to 92.1%) Attendings: 92.3% (81.8% to 97.0%) Residents: 85.1% (76.5% to 90.9%)	All physicians: 65.0% (56.1% to 72.9%) Attendings: 73.3% (59.0% to 84.0%) Residents: 60.0% (48.7% to 70.3%)	NA	All physicians: LR (+): 2.51 (1.95 to 3.22) LR (-): 0.19 (0.12 to 0.30) Attendings: LR (+): 3.46 (2.12 to 5.66) LR (-): 0.11 (0.04 to 0.27) Residents: LR (+): 2.13 (1.59	Overall: correctly predicted in 77% of observations

Study	Population	Tool	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
								to 2.84) LR (-): 0.25 (0.15 to 0.42)	
				Ability to predict disposition (Non-intensive care unit [ICU] vs ICU)	All physicians: 60.0% (42.3% to 75.4%) Attendings: 77.8% (45.3% to 93.7%) Residents: 52.4% (32.4% to 71.7%)	All physicians: 95.9% (90.0% to 98.4%) Attendings: 94.9% (83.1% to 98.6%) Residents: 96.6% (88.5% to 99.1%)	NA	All physicians: LR (+): 14.7 (5.39 to 40.1) LR (-): 0.42 (0.27 to 0.65) Attendings: LR (+): 15.2 (3.76 to 61.16) LR (-): 0.23 (0.07 to 0.80) Residents: LR (+): 15.5 (3.73 to 64.1) LR (-): 0.49 (0.31 to 0.77)	NA
				Ability to predict patient acuity (sick vs not sick)	All physicians: 66.2% (55.1% to 75.8%) Attendings: 73.1% (53.9% to 86.3%) Residents:	All physicians: 88.4% (83.0% to 92.2%) Attendings: 83.1% (72.7% to 90.1%) Residents:	All physicians: PPV: 69.9% (58.6% to 79.2%) NPV: 86.5% (81.0% to 90.6%)	All physicians: LR (+): 5.69 (3.72 to 8.69) LR (-): 0.38 (0.28 to 0.53) Attendings: LR (+): 4.32 (2.46 to 7.62)	Overall: correctly predicted in 82% of observations

Study	Population	Tool	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)
					62.7% (49.0% to 74.7%)	91.5% (85.1% to 95.3%)	Attendings: PPV: 61.3% (43.8% to 76.3%) NPV: 89.4% (79.7% to 94.8%) Residents: PPV: 76.2% (61.5% to 86.5%) NPV: 85.0% (77.8% to 90.2%)	LR (-): 0.32 (0.17 to 0.62) Residents: LR (+): 7.40 (3.95 to 13.90) LR (-): 0.41 (0.28 to 0.58)	

AUC: Area under the curve, AUROC: Area under the receiver operating characteristic curve, CI: Confidence Interval, ED: Emergency Department, LR (-): Negative Likelihood Ratio, LR (+): Positive Likelihood Ratio, NA: Not Applicable, NPV: Negative Predictive Value, PPV: Positive Predictive Value, ROC: Receiver operating characteristic curve

6. How have these models, systems and tools been implemented?

We found limited evidence on the implementation of tools and systems (citations are provided in *Appendix 7: Citations of studies reporting on the implementation of models/systems/tools*). Three papers addressed implementation and are summarised here.

McCabe et al. (2019)

McCabe et al. (2019) reported the implementation of a new acuity assessment process based on the use of the Early Warning Score (EWS) in conjunction with the Manchester Triage System (MTS) in the emergency department (ED) of a large hospital in Ireland from September 2015 to September 2016. A total of 10,048 adult patients (female: 51%; mean age (SD): 46.4 (20.1)) presenting at the ED with various health complaints were retrospectively included. The time periods of interest were 3 months before the introduction of the intervention (September 2015), the month of the intervention implementation (December 2015) and 9 months post-implementation (September 2016).

The EWS implementation was led by a Clinical Nurse Specialist (CNS) and a Quality improvement cycle approach was used. Workshop trainings were organised for all clinical staff in the ED department and the CNS was available to answer questions from staff. An evaluation was done post-implementation, and further training was deemed necessary to improve staff performance in the use of MTS and EWS. An audit of ED presentations 6 weeks after the follow-up training showed improvement in the accuracy of acuity assessment categorisations by ED staff.

The impact of the EWS implementation was evaluated on 2 main outcomes: MTS categorisation and patient waiting times (see Table 8). It was observed that the introduction of the EWS resulted in an increased proportion of patients being assigned a higher MTS category (especially MTS category 2, $p<0.001$). However, patient waiting times increased across all MTS categories, the difference being statistically significant for MTS categories 2 to 5. The investigators contrasted these findings in the small proportion of patients with an EWS score > 6 who had been categorised as non-urgent (MTS 3-5), suggesting that the resulting increase in waiting time because of MTS categorisation could be of clinical significance. This means that EWS may be a more sensitive tool to detect patient deterioration and could be useful for a more conservation approach to patient management if used in conjunction with MTS.

Table 8: Analysis of patient waiting times comparing pre, early implementation and post implementation of EWS based on MTS groupings (from McCabe et al. (2019))

	3 months pre implementation	Implementation month	9 months follow-up	P value	Kruskal-Wallis score
MTS 1 patients only					
Waiting time (mins) from acuity assessment to see a clinician (n = 92)	Median = 7.5 (n = 46)	Median = 11 (n = 22)	Median = 11 (n = 24)	0.116	4.3
Total time in department (min) (acuity assessment to left ED) (n = 104)	Median = 498 (n = 47)	Median = 289 (n = 28)	Median = 396 (n = 29)	0.153	3.8
MTS 2 patients only					
Waiting time from acuity assessment to see a clinician (min) (n = 2301)	Median = 18 (n = 709)	Median = 19 (n = 767)	Median = 21 (n = 825)	0.034*	6.79
Total time (min) in ED (acuity assessment to left department) (n = 2412)	Median = 387 (n = 745)	Median = 391 (n = 812)	Median = 475 (n = 855)	0.001*	48.7
MTS 3-5 patients only					
Waiting time from acuity assessment to see a clinician (min) (n = 6629)	Median = 88 (n = 2788)	Median = 136 (n = 1864)	Median = 147 (n = 1977)	< 0.001*	255.94

Total time (min) in ED (acuity assessment to leaving) (n = 7511)	Median = 261 (n = 3148)	Median = 342 (n = 2137)	Median = 386 (n = 2226)	< 0.001*	399.27

*significant

Shea et al. (2012)

Shea et al. (2012) described the implementation of a "RAPID" (Rapid Assessment Plan Intervention and Disposition) team concept in the emergency department (ED) of an urban community hospital in Los Angeles, United States, in 2009. The RAPID team acuity assessment was designed to eliminate all unnecessary steps between the patient's arrival in the ED and his or her contact with a nurse practitioner (NP)/physician assistant (PA), or medical doctor (MD). The aim was a rapid medical assessment and completion of the medical screening examination (MSE) by a provider within minutes of the patient's arrival.

An analysis of the current patient flow as well as the physical configuration of the ED revealed the various bottlenecks and domains that needed improvement. It was followed by a 3-month pilot phase during which champions from nursing management were actively involved in socialising the ED staff about the new team process. It was a continuous improvement cycle, with changes made depending on the challenges encountered during the process. Patients were greeted at the door and escorted directly to the next available fast track bed. Only enough information was collected to enter the patient into the computerized tracking system. The patient, if able, completed a quick registration form. Any available member of the team then initiated an abbreviated intake form focused on chief complaint and vital signs. The actual MSE was performed by the assigned "RAPID" NP/PA or MD. A form was designed and amended during the process to capture all the essential information and thus facilitate documentation and communication.

At the time of the report, the team implementing this RAPID team approach were able to complete the required MSE within 30 minutes in more than 90% of cases and easily meet the metrics for vital signs and nursing assessment for required screening of risk factors such as fall and sepsis.

Whitfield (2013)

Whitfield (2013) described the implementation of a Quality improvement project (QIP) called "Embedding Emergency Severity Score (ESI)" in the ED of a healthcare facility located in South-Eastern United States in 2013. The QIP aimed to answer: "In the emergency department setting, does the implementation of an electronic, acuity assistance template embedded in the electronic medical record (EMR) and completed by ED registered nurses (RNs) improve the acuity assessment efficiency, decrease the number of patients who "left without treatment" (LWOT), and improve RN satisfaction of the acuity assessment process in the adult patient population?"

The ESI is the ED acuity assessment score recommended by the American College of Emergency Physicians and the Emergency Nurses Association and was already used in the ED of the implementation site prior to the QIP, but it was not embedded in the EMR of patients. The "embedding ESI" project consisted of integrating an electronic version of the ESI into the software (Wellsoft) used for the EMR system. The design of "Embedding ESI" included the development of the ESI acuity assessment system into a click-and-drop template within the EMR. The click-and-drop template was added to the nurse's note section of the EMR in the chart field allotted for the acuity assessment note. When the RN clicked on the adult triage tool on the triage screen, there was an ESI template added to the nurse's triage screen. With new patients, RNs were encouraged to use the four components of the ESI acuity assessment system for the decided acuity level. It was piloted for Summer 2023 and went live in the ED's EMR on June 1, 2013.

The implementation of the "Embedding ESI" QIP resulted in a slight increase in the average "door to acuity assessment" time, from 8.6 minutes (March through May 2023) to 10 minutes (June through August 2013, the implementation period). However, there was a significant reduction in the "acuity assessment to ED patient care area" (the time from when acuity assessment is completed until when the patients arrive in the corresponding acuity-level patient area) from 51 minutes before "Embedding ESI (March through May 2013) to 34.3 minutes during the implementation (June through August 2013). Moreover, the number of patients who left the ED without acuity assessment, or triage (LWOT) decreased from 385 (7.2%) in March 2013 to 264 (4.8%) in August 2013.

Finally, qualitative analysis of RNs' self-reflection surveys before and after "embedding ESI" revealed that they were satisfied with the acuity assessment process and the electronic, acuity assistance template (ESI) embedded in the EMR.

7. How and why does implementation vary across contexts?

This review did not find enough studies to be able to analyse the difference in implementation across contexts.

8. Review team

Evidence review lead:	Alison Turner
Literature searching:	Patricia Lacey
Evidence mapping:	Jennifer Y.Y. Kam Aurelien Tejiozem Alison Martin
Analysis:	Jennifer Y.Y. Kam Aurelien Tejiozem Alison Martin
Summary and synthesis:	Jennifer Y.Y. Kam Aurelien Tejiozem Alison Martin Alison Turner

9. Appendices

Appendix 1: Our approach to the review

The review was based on the Quick Scoping Review method[2], developed in the civil service to inform policy and strategy decisions. The review protocol was agreed with the project advisory group at the start of the project and subsequent decisions were agreed via fortnightly project group meetings. The following details provide a description of the approach taken.

Framing the review		
Populations of interest	Clinicians in Emergency Departments applying acuity measures (to patients presenting)	
Interventions	Models for defining and determining acuity in ED (these may be described in the literature as triage models) *The project team so far have identified three models in use: expert practitioner; algorithmic; and hybrid.*	
Settings	Emergency Departments (potentially ambulance services and urgent care services)	
Outcomes of interest	• Efficacy of the tools (including validity, reliability, and applicability) • Efficiency (e.g., ease of use; time factors) • Impacts on patient care (e.g., equity; safety) • Implementation lessons (e.g., acceptability, feasibility, satisfaction, experience)	
Scope		
	Included	**Excluded**
Geographical scope	International *(Countries of interest: Canada; Australia; New Zealand; Hong Kong; Taiwan – include US but with caveats) OECD?*	LMICs (limited transferability)
Settings	Emergency Department	Community services
Evidence types	• Research studies • Evaluations • Analytical reports • Ongoing research	
Date restrictions	Last 10 years to focus on contemporary literature	
Search sources and locations		
Bibliographic databases	• Medline • HMIC • CINAHL	

[2] https://webarchive.nationalarchives.gov.uk/ukgwa/20140402164155/http://www.civilservice.gov.uk/networks/gsr/resources-and-guidance/rapid-evidence-assessment

	• Preprint servers (e.g., osfpreprints)
Grey literature	Research bodies • National Institute for Health Research (NIHR) • NIHR Applied Research Collaborations (ARCs) Aggregators and search engines: • TRIP / Epistemonikos NHS and professional sources: • NHS England • National Grey Literature Collection • Future NHS platform • Royal College of Emergency Medicine • Royal College of Nursing • Faculty of Emergency Nursing • ECIST (Emergency Care Improvement Support Team) • GIRFT (Getting It Right First Time) • CQC Trials registries (limited to US and European registries as most transferable to NHS context) • Clinicaltrials.gov • www.clinicaltrialsregister.eu
Search strategy	The following search strategy was developed for MEDLINE and adapted for CINAHL and HMIC: 1. acuity measur*.mp. 2. Manchester Triage System*.mp. 3. Canadian Triage Acuity Scale*.mp. 4. Emergency Severity Index*.mp. 5. South African Triage System*.mp. 6. Australian Triage Scale*.mp. 7. Australasian Triage Scale*.mp. 8. (Taiwan Triage and Acuity Scale*).mp. 9. Patient acuity.mp. or *Patient Acuity/ 10. (acuity adj3 (score or measure or allocate* or assess* or scale)).ti,ab,kw,kf. 11. (Severity adj1 illness).ti,ab,kw,kf. 12. (Triage adj3 (model* or method* or standard*)).mp. 13. Triage/st [Standards] 14. NEWS2.mp. 15. National Early Warning Score 2.mp.

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<td>16. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15
17. Emergency room.mp. or Emergency Service, Hospital/mt, st [Methods, Standards]
18. emergency department*.mp.
19. (accident adj1 emergency).mp.
20. Emergency medical service*.mp. or Emergency Medical Services/st [Standards]
21. urgent care.mp.
22. 17 or 18 or 19 or 20 or 21
23. 16 and 22
24. limit 23 to (english language and humans and yr="2012 - 2023")

[mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]

Grey literature searches were conducted during November 2022, using a combination of search terms (see below) and menu browsing:
• acuity measure/s
• Manchester Triage System
• Canadian Triage Acuity Scale
• Emergency Severity Index
• South African Triage System
• Australian Triage Scale
• Australasian Triage Scale
• Taiwan Triage and Acuity Scale
• National Early Warning Score 2
• Patient acuity</td>
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<td colspan="2">Preparing the review</td>
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<tr>
<td>Title and abstract screening</td>
<td>The results were deduplicated and an initial title screen performed by the Strategy Unit.

Crystallise then undertook a detailed title/abstract screen. The first 10% of abstracts were screened by two researchers independently and the results compared, with any discrepancies discussed with the project leader. Those abstracts that met the inclusion criteria were shortlisted as follows:
• Assessed the effectiveness of acuity tool or processes or streaming in a general population of adults, children or mixed ages attending ED
• Guidelines on the use of triage in patients attending ED

Studies were included in the Map if they assessed the use of triage tools or processes or streaming in a general population attending an ED or were guidelines on triage of</td>
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	patients in ED. Studies were not included in the Map if they assessed the use of a tool in a specific subgroup of ED attendees with one type of problem, reported the views of staff or on how staff are trained or assessed in using the tool, where the performance of the tool or triage approach was not the focus of the research or the study assessed only workflow through the ED, or where the publication was a study protocol with no results published. 187 relevant abstracts were identified as relevant for mapping.
Mapping	The Evidence Map shows all the abstracts identified after abstract screening, sorted into different fields and different subcategories within each field. Users can see the number of studies relevant to each subcategory within each field.

Full text screening	The Evidence Map was used to shortlist 40 publications for full-text review using the following criteria:
	• Systematic literature reviews published from 2017 onwards.
	• Studies reporting on the accuracy of a triage tool for short-term outcomes:
	  ○ Mortality within 48 hours of presenting at ED
	  ○ Time to triage
	  ○ Time to treatment
	  ○ Admission to hospital
	  ○ Admission to ICU
	  ○ Length of stay in ED
	• Studies reporting on the implementation of a triage tool or process in the UK, Ireland, Australia, Canada or unclear location.
	
	These 40 papers were screened for relevant data and 19 papers were included in the review. Data from these papers was extracted by one researcher and checked by the project leader for accuracy and comprehensiveness.

Synthesis	
Approach	Using the data extracted, summaries were prepared for each of the agreed research questions. Tables are provided where there is a large volume of data.

Appendix 2: Advisory Group membership

Dr Ben Bloom	Consultant in Emergency Medicine, and Researcher Bart's Health NHS Trust Senior Lecturer, Queen Mary University of London
Dr Kirsty Challen	Consultant in Emergency Medicine and Emergency Medicine Research Lead, Lancashire Teaching Hospitals NHS Foundation Trust
Prof Robert Crouch	Consultant Nurse & Honorary Professor of Emergency Care, Emergency Department University Hospital Southampton NHS Foundation Trust/University of Southampton Visiting Professor, Faculty of Health and Applied Sciences, University of the West of England
Dr Tom Hughes	Consultant in Emergency Medicine, John Radcliffe Hospital, Oxford Emergency Care Dataset lead, NHS England
Sade Matakitoga	Senior Programme Manager Hospitals Transformation Team (non–admitted), Emergency and Elective Care Directorate, NHS England

Appendix 3: Citations of studies reporting use of acuity assessment tools

(*Tools from Evidence Mapper in **black** color, Tools from non-Evidence Mapper in **blue** color)

Tool	Full Citations
57-item deficit accumulation frailty index (FI-CGA)	Pulok, M. H., et al. (2020). "The role of illness acuity on the association between frailty and mortality in emergency department patients referred to internal medicine." Age & Ageing 49(6): 1071-1079.
Acute Physiology and Chronic Health Evaluation II (APACHE II) score	Anonymous (2018). "Comparison of various severity assessment scoring systems in patients with sepsis in a tertiary care teaching hospital." Indian Journal of Critical Care Medicine 22(12): 842-845. Travaglino, F., et al. (2012). "Utility of Procalcitonin (PCT) and Mid regional pro-Adrenomedullin (MR-proADM) in risk stratification of critically ill febrile patients in Emergency Department (ED). A comparison with APACHE II score." BMC Infectious Diseases 12(1): 184-184. Seak, C.-J., et al. (2014). "Performance assessment of the Simplified Acute Physiology Score II, the Acute Physiology and Chronic Health Evaluation II score, and the Sequential Organ Failure Assessment score in predicting the outcomes of adult patients with hepatic portal venous gas in the ED." American Journal of Emergency Medicine 32(12): 1481-1484. Colussi, G., et al. (2021). "Prognostic scores and early management of septic patients in the emergency department of a secondary hospital: results of a retrospective study." BMC Emergency Medicine 21(1): 152. Jo, S., et al. (2013). "Modified early warning score with rapid lactate level in critically ill medical patients: the ViEWS-L score." Emergency Medicine Journal 30(2): 123-129. Williams, J. M., et al. (2016). "Severity Scores in Emergency Department Patients With Presumed Infection: A Prospective Validation Study." Critical Care Medicine 44(3): 539-547.
Ambulatory Score (Ambs)	Cameron, A., et al. (2018). "Comparison of Glasgow Admission Prediction Score and Amb Score in predicting need for inpatient care." Emergency Medicine Journal 35(4): 247-251.
Andorran Triage Model	Monclus Cols, E., et al. (2018). "Comparison of the Quick Sepsis-related Organ Dysfunction score and severity levels assigned with the Andorran Triage Model in an urban tertiary care hospital emergency department." Emergencias 30(6): 400-404.
Andorran Triage Model/Spanish Triage System (MAT/SET)	Miro, O., et al. (2016). "Short-term predictive capacity of two different triage systems in patients with acute heart failure: TRICA-EAHFE study." 1(6): 435-441.
APOP screener	de Gelder, J., et al. (2018). "Optimization of the APOP screener to predict functional decline or mortality in older emergency department patients: Cross-validation in four prospective cohorts." Experimental Gerontology 110: 253-259.
Australasian Triage Scale (ATS)	Allen, A. R., et al. (2015). "Accuracy and interrater reliability of paediatric emergency department triage." 1(5): 447-52.

Tool	Full Citations
	Alpert, E. A., et al. (2013). "Simulated evaluation of two triage scales in an emergency department in Israel." 1(6): 431-4. Burgess, L., et al. (2019). "Implementing best practice into the emergency department triage process." International Journal of Evidence-Based Healthcare 17(1): 27-35. Cheng, D. R., et al. (2016). "Effect of a pager notification system on Australasian Triage Scale category 2 patients in a paediatric emergency department." 1(4): 434-8. Ebrahimi, M., et al. (2015). "The reliability of the Australasian Triage Scale: a meta-analysis." World Journal of Emergency Medicine 6(2): 94-99. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227. Varndell, W., et al. (2019). "The use and feasibility of an online software system to support assessment of accuracy and consistency in applying the Australasian Triage Scale." Australasian Emergency Care 22(3): 168-173. McCarthy, M., et al. (2013). "Triage of pregnant women in the emergency department: evaluation of a triage decision aid." 1(2): 117-22. Sandy Middleton, S. D. N. W. C. D. A. C. J. M. G. C. L. E. M. J. C. P. M. R. G. L. E. C. V. S. M. F. (2019). "Nurse-Initiated Acute Stroke Care in Emergency Departments." EvidenceUpdates: STROKEAHA118020701. Aboagye - Sarfo, P., et al. (2016). "Impact of population ageing on growing demand for emergency transportation to emergency departments in Western Australia, 2005-2020." Emergency Medicine Australasia 28(5): 551-557. Allen, M. T., et al. (2021). "Emergency department presentations in the Southern District of New Zealand during the 2020 COVID-19 pandemic lockdown." Emergency Medicine Australasia 33(3): 534-540. Anthony R Burrell, M.-L. M. M. F. R. B. S. D. S. (2016). "SEPSIS KILLS: early intervention saves lives." Medical Journal of Australia: 73. Daniel, C., et al. (2021). "Characteristics and clinical outcomes for mental health patients admitted to a behavioural assessment unit: Implications for model of care and practice." International Journal of Mental Health Nursing 30(1): 249-260. Nagree, Y. and Darwent, B. (2020). "Characterising the number and type of presentations to a tertiary emergency department by young people affected by drugs and alcohol." Australian Health Review 44(4): 637-641. Stephen A Margolis, R. M. V. A. Y. B. L. (2016). "Changing paediatric emergency department model of care is associated with improvements in the National Emergency Access Target and a decrease in inpatient admissions." Emergency medicine Australasia: 711-715. Thornton, V., et al. (2014). "Why do patients self-present to Middlemore Hospital Emergency Department?" 1(1394): 19-30.

Tool	Full Citations
	Varndell, W., et al. (2018). "Development and preliminary testing of an online software system to facilitate assessment of accuracy and consistency in applying the Australasian Triage Scale." Australasian Emergency Care 21(4): 150-158. Chamberlain, D. J., et al. (2015). "Identification of the severe sepsis patient at triage: a prospective analysis of the Australasian Triage Scale." 1(9): 690-7. Nevill, A., et al. (2021). "The influence of nurse allocated triage category on the care of patients with sepsis in the emergency department: A retrospective review." Australasian Emergency Care 24(2): 121-126. Jayaweera, D., et al. (2014). "A comparison of emergency triage scales in triaging poisoned patients." 1(4): 184-9. Middleton, S., et al. (2016). "Triage, treatment and transfer of patients with stroke in emergency department trial (the T3 Trial): a cluster randomised trial protocol." Implementation Science 11(1): 139-139.
BPA (best-practice alert) - automated sensitive triage tool	Cruz, A. T., et al. (2012). "Test characteristics of an automated age- and temperature-adjusted tachycardia alert in pediatric septic shock." Pediatric Emergency Care 28(9): 889-894.
Canadian Triage and Acuity Scale (CTAS)	Akira Kuriyama, S. U. T. N. (2017). "Five-level emergency triage systems: variation in assessment of validity." Emergency Medicine Journal: 703-710. Amir Mirhaghi, A. H. R. M. M. E. (2015). "The Reliability of the Canadian Triage and Acuity Scale: Meta-analysis." North American journal of medical sciences: 299-305. Daren Lin, A. W. (2013). "Predictors of admission to hospital of patients triaged as nonurgent using the Canadian Triage and Acuity Scale." CJEM: 353-8. Fernandes, C. M., et al. (2013). "Reliability of the Canadian Triage and Acuity Scale: interrater and intrarater agreement from a community and an academic emergency department." 1(4): 227-32. Gravel, J., et al. (2012). "The Canadian Triage and Acuity Scale for children: a prospective multicenter evaluation." 1(1): 71-7.e3. Howlett, M. K. and Atkinson, P. R. (2012). "A method for reviewing the accuracy and reliability of a five-level triage process (canadian triage and acuity scale) in a community emergency department setting: building the crowding measurement infrastructure." Emergency Medicine International Print 2012: 636045. Joany M Zachariasse, V. v. d. H. N. S. K. M.-J. M. v. V. H. A. M. (2019). "Performance of triage systems in emergency care: a systematic review and meta-analysis." BMJ open: e026471. Preyde, M., et al. (2012). "Patients' satisfaction and wait times at Guelph General Hospital Emergency Department before and after implementation of a process improvement project." 1(3): 157-68. Smith, D. T., et al. (2015). "Analyzing the Usability of the 5-Level Canadian Triage and Acuity Scale By Paramedics in the Prehospital Environment." 1(6): 489-95. Trivedi, S., et al. (2021). "A Comparison Between Computer-Assisted Self-Triage by Patients and Triage Performed by Nurses in the Emergency Department." Cureus

Tool	Full Citations
	13(3): e14002. Downey, L. V. A., et al. (2015). "Comparison of Canadian triage acuity scale to Australian Emergency Mental Health Scale triage system for psychiatric patients." International Emergency Nursing 23(2): 138-143. Pulok, M. H., et al. (2020). "The role of illness acuity on the association between frailty and mortality in emergency department patients referred to internal medicine." Age & Ageing 49(6): 1071-1079. Davis, S., et al. (2022). "Impact of Pain Assessment on Canadian Triage and Acuity Scale Prediction of Patient Outcomes." Annals of Emergency Medicine 79(5): 433-440. Davis, S., et al. (2022). "The Effect of Human Supervision on an Electronic Implementation of the Canadian Triage Acuity Scale (CTAS)." Journal of Emergency Medicine 28: 28. Anne-Marie Brown, D. E. C. J. S. (2015). "Canadian Triage and Acuity Scale: testing the mental health categories." Open access emergency medicine : OAEM: 79-84. Almubarak, H., et al. (2019). "Factors and outcomes associated with paediatric emergency department arrival patterns through the day." Paediatrics & Child Health (1205-7088) 24(5): 323-329. Lobay, K., et al. (2017). "Transport determinants for continuing care residents assessed by an EMS urgent response team: A retrospective observational study." Canadian Journal of Emergency Nursing (CJEN) 40(2): 44-46. Melon, K. A., et al. (2013). "Beat the clock! Wait times and the production of 'quality' in emergency departments." 1(3): 223-37. Petruniak, L., et al. (2018). "Exploring the Predictors of Emergency Department Triage Acuity Assignment in Patients With Sepsis." Canadian Journal of Nursing Research 50(2): 81-88. Rankin, J. A., et al. (2013). "Can emergency nurses' triage skills be improved by online learning? Results of an experiment." Journal of Emergency Nursing 39(1): 20-6. Ryan Andres, E. H. S. d. K. R. S. J. D. A. B. (2017). "Design and Implementation of a Trauma Care Bundle at a Community Hospital." BMJ Quality Improvement Reports. Simbawa, J. H., et al. (2021). "The Association Between Abnormal Vital Signs and Mortality in the Emergency Department." Cureus 13(12): e20454. Weerasinghe, S. S. and Campbell, S. G. (2021). "Identifying Acuity Level-Based Adult Emergency Department Use Time Trends Across Demographic Characteristics." Cureus 13(2): e13225. Yip, A., et al. (2012). "Influence of publicly available online wait time data on emergency department choice in patients with noncritical complaints." CJEM: Canadian Journal of Emergency Medicine 14(4): 233-242. Bullard, M. J., et al. (2017). "Guidance when Applying the Canadian Triage and

Tool	Full Citations
	Acuity Scale (CTAS) to the Geriatric Patient: Executive Summary." 1(S2): S28-s37. Fabrice Mowbray, A.-A. B. E. M. D. M. M. É. A. P. C. (2019). "Examining the relationship between triage acuity and frailty to inform the care of older emergency department patients: Findings from a large Canadian multisite cohort study." EvidenceUpdates: 74-81. Leeies, M., et al. (2017). "Prehospital Application of the Canadian Triage and Acuity Scale by Emergency Medical Services." 1(1): 26-31.
Clinical Decision Support System (CDSS)	Bennett, P. and Hardiker, N. (2016). "A Quantitative Study Investigating the Effects of Computerised Clinical Decision Support in the Emergency Department." 1: 53-7. Feral-Pierssens, A.-L., et al. (2022). "Safety assessment of a redirection program using an electronic application for low-acuity patients visiting an emergency department." BMC Emergency Medicine 22(1): 1-9. Glass, G., et al. (2021). "Dynamic data in the ED predict requirement for ICU transfer following acute care admission." Journal of Clinical Monitoring & Computing 35(3): 515-523. Kunisch, J. M. (2012). Improving emergency department triage classification with computerized clinical decision support at a pediatric hospital. University of Colorado at Denver. 71 p-71 p. Dean, N. C., et al. (2015). "Impact of an Electronic Clinical Decision Support Tool for Emergency Department Patients With Pneumonia." 1(5): 511-20.
Clinical Frailty Scale (CFS)	Elliott, A., et al. (2021). "Does the Clinical Frailty Scale at Triage Predict Outcomes From Emergency Care for Older People?" Annals of Emergency Medicine 77(6): 620-627. McGrath, J., et al. (2019). "The Whittington Frailty Pathway: improving access to comprehensive geriatric assessment: an interdisciplinary quality improvement project." BMJ Open Quality 8(4): e000798. Pulok, M. H., et al. (2020). "The role of illness acuity on the association between frailty and mortality in emergency department patients referred to internal medicine." Age & Ageing 49(6): 1071-1079. Wall, J. and Wallis, S. J. (2014). "109 CAN A FRAILTY SCALE BE USED TO TRIAGE ELDERLY PATIENTS FROM EMERGENCY DEPARTMENT TO GERIATRIC WARDS?" Age & Ageing 43(suppl_1): i30-i30. O'Shaughnessy, Í., et al. (2019). "286 Predictors and Outcomes of Older Persons Attending the Emergency Department of a Large Acute Dublin Teaching Hospital...67th Annual & Scientific Meeting of the Irish Gerontological Society, Innovation, Advances and Excellence in Ageing, 26–28 September 2019, Cork, Ireland." Age & Ageing 48: iii17-iii65. Rueegg, M., et al. (2022). "The clinical frailty scale predicts 1-year mortality in emergency department patients aged 65 years and older." Academic Emergency Medicine 29(5): 572-580. Dowell, H., et al. (2021). "IMPROVING FRAILTY SCREENING AND ACCURACY IN

Tool	Full Citations
	THE EMERGENCY DEPARTMENT (ED) OF A BUSY DISTRICT GENERAL HOSPITAL...British Geriatrics Society Autumn Meeting, November 25-27 2020 (Virtual)." Age & Ageing 50: i1-i1.
Danish Emergency Process Triage (DEPT)	Iversen, A. K. S., et al. (2019). "A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department." Emergency Medicine Journal 36(2): 66-71.
Deep-learning-based Triage and Acuity Score (DTAS)	Kwon, J. M., et al. (2018). "Validation of deep-learning-based triage and acuity score using a large national dataset." PLoS ONE [Electronic Resource] 13(10): e0205836.
Dynamic Grouping and Prioritization (DGP) algorithm	Ashour, O., et al. (2016). "Dynamic patient grouping and prioritization: a new approach to emergency department flow improvement." Health Care Management Science 19(2): 192-205.
Early Warning Scores (EWS)	Burgos-Esteban, A., et al. (2022). "Effectiveness of Early Warning Scores for Early Severity Assessment in Outpatient Emergency Care: A Systematic Review." Frontiers in Public Health 10: 894906. Griffiths, J. R., et al. (2012). "Current use of early warning scores in UK emergency departments." Emergency Medicine Journal 29(1): 65-66. Guan, G., et al. (2022). "The use of early warning system scores in prehospital and emergency department settings to predict clinical deterioration: A systematic review and meta-analysis." PLoS ONE [Electronic Resource] 17(3): e0265559. Martin-Rodriguez, F., et al. (2019). "Analysis of the early warning score to detect critical or high-risk patients in the prehospital setting." Internal & Emergency Medicine 14(4): 581-589. McCabe, C., et al. (2019). "The introduction of the Early Warning Score in the Emergency Department: A retrospective cohort study." International emergency nursing 45: 31-35. Pullinger, R., et al. (2017). "Implementing an electronic observation and early warning score chart in the emergency department: a feasibility study." European Journal of Emergency Medicine 24(6): e11-e16.
East Midlands, North West and Northern prehospital triage tools	Ardolino, A., et al. (2015). "The accuracy of existing prehospital triage tools for injured children in England: an analysis using emergency department data." Emergency Medicine Journal 32(5): 397-400.
eccSOFA	Niknam, K., et al. (2021). "eccSOFA: SOFA illness severity score adapted to predict in-hospital mortality in emergency critical care patients." American Journal of Emergency Medicine 41: 145-151.
Echelle Liegeoise d'Index de Severite a l'Admission (ELISA)	Jobe, J., et al. (2014). "Reliability and validity of a new French-language triage algorithm: the ELISA scale." 1(2): 115-20.
ED Sequential Organ Failure Assessment (SOFA) score	Vogel, J. A., et al. (2015). "Denver ED Trauma Organ Failure Score outperforms traditional methods of risk stratification in trauma." 1(10): 1440-4.
Electronic Canadian Triage and Acuity Scale (eCTAS)	Agnihotri, T., et al. (2021). "Impact of an Electronic Decision-Support System on Nursing Triage Process: A Usability and Workflow Analysis." Canadian Journal of

Tool	Full Citations
	Nursing Research 53(2): 107-113. McLeod, S. L., et al. (2020). "Interrater Reliability, Accuracy, and Triage Time Pre- and Post-implementation of a Real-Time Electronic Triage Decision-Support Tool." Annals of Emergency Medicine 75(4): 524-531.
Electronic patient self-triage	Dickson, S. J., et al. (2022). "Agreement and validity of electronic patient self-triage (eTriage) with nurse triage in two UK emergency departments: a retrospective study." European Journal of Emergency Medicine 29(1): 49-55. Trivedi, S., et al. (2021). "A Comparison Between Computer-Assisted Self-Triage by Patients and Triage Performed by Nurses in the Emergency Department." Cureus 13(3): e14002.
Emergency Department Triage Early Warning Score (TREWS)	Lee, S. B., et al. (2020). "Emergency Department Triage Early Warning Score (TREWS) predicts in-hospital mortality in the emergency department." American Journal of Emergency Medicine 38(2): 203-210. Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606.
Emergency Nurses Association Emergency Severity Triage	Downey, L. V. A., et al. (2014). "Comparison of Emergency Nurses Association Emergency Severity Triage and Australian Emergency Mental Health Triage Systems for the Evaluation of Psychiatric Patients." Journal of Ambulatory Care Management 37(1): 11-19.
Emergency Severity Index (ESI)	Akira Kuriyama, S. U. T. N. (2017). "Five-level emergency triage systems: variation in assessment of validity." Emergency Medicine Journal: 703-710. Alpert, E. A., et al. (2013). "Simulated evaluation of two triage scales in an emergency department in Israel." 1(6): 431-4. Ashour, O., et al. (2016). "Dynamic patient grouping and prioritization: a new approach to emergency department flow improvement." Health Care Management Science 19(2): 192-205. Bergs, J., et al. (2014). "Evaluating Implementation of the Emergency Severity Index in a Belgian Hospital." Journal of Emergency Nursing 40(6): 592-597. Brosinski, C. M., et al. (2017). "Improving Triage Accuracy: A Staff Development Approach." 1(3): 145-148. Burgess, M. J. (2017). "Implementation Of The Emergency Severity Index (ESL) Triage Tool in an Urgent Care Setting: A DNP Project." Implementation Of The Emergency Severity Index (ESL) Triage Tool in an Urgent Care Setting: A DNP Project: 1-1. Busch, J.-M., et al. (2022). "Validation of a Simple Score for Mortality Prediction in a Cohort of Unselected Emergency Patients." International Journal of Clinical Practice: 1-9. Buschhorn, H. M., et al. (2013). "Emergency medical services triage using the emergency severity index: is it reliable and valid?" 1(5): e55-63. Cairos-Ventura, L. M., et al. (2019). "Validity and Reliability of the Emergency

Tool	Full Citations
	Severity Index in a Spanish Hospital." International Journal of Environmental Research & Public Health [Electronic Resource] 16(22): 18. Darnton, P., et al. (2018). "Independent evaluation of the North East Hampshire and Farnham Vanguard: emergency severity index." Dateo, J. (2013). "What factors increase the accuracy and inter-rater reliability of the Emergency Severity Index among emergency nurses in triaging adult patients?" Journal of Emergency Nursing 39(2): 203-7. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Green, N. A., et al. (2012). "Emergency Severity Index version 4: a valid and reliable tool in pediatric emergency department triage." 1(8): 753-7. Grossmann, F. F., et al. (2012). "At risk of undertriage? Testing the performance and accuracy of the emergency severity index in older emergency department patients." 1(3): 317-25.e3. Hong, R., et al. (2015). "Comparison of START triage categories to emergency department triage levels to determine need for urgent care and to predict hospitalization." 1(1): 13-21. Joany M Zachariasse, V. v. d. H. N. S. K. M.-J. M. v. V. H. A. M. (2019). "Performance of triage systems in emergency care: a systematic review and meta-analysis." BMJ open: e026471. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227. Kwak, H., et al. (2018). "Prognostic performance of Emergency Severity Index (ESI) combined with qSOFA score." American Journal of Emergency Medicine 36(10): 1784-1788. Levin, S., et al. (2018). "Machine-Learning-Based Electronic Triage More Accurately Differentiates Patients With Respect to Clinical Outcomes Compared With the Emergency Severity Index." Annals of Emergency Medicine 71(5): 565-574.e2. McHugh, M., et al. (2012). "More patients are triaged using the Emergency Severity Index than any other triage acuity system in the United States." 1(1): 106-9. Mirhaghi, A., et al. (2015). "Reliability of the Emergency Severity Index: Meta-analysis." Sultan Qaboos University medical journal 15(1): e71-7. Mistry, B., et al. (2018). "Accuracy and Reliability of Emergency Department Triage Using the Emergency Severity Index: An International Multicenter Assessment." Annals of Emergency Medicine 71(5): 581-587.e3.

Tool	Full Citations
	Möckel, M., et al. (2020). "["Triage"-primary assessment of patients in the emergency department : An overview with a systematic review]." Medizinische Klinik, Intensivmedizin und Notfallmedizin 115(8): 668-681. Raita, Y., et al. (2019). "Emergency department triage prediction of clinical outcomes using machine learning models." Critical Care (London, England) 23(1): 64. Singer, R. F., et al. (2012). "The use of and satisfaction with the Emergency Severity Index." 1(2): 120-6. Smith, D. T., et al. (2015). "Analyzing the Usability of the 5-Level Canadian Triage and Acuity Scale By Paramedics in the Prehospital Environment." 1(6): 489-95. Takaoka, K., et al. (2021). "Utility of the Emergency Severity Index by Accuracy of Interrater Agreement by Expert Triage Nurses in a Simulated Scenario in Japan: A Randomized Controlled Trial." Journal of Emergency Nursing 47(4): 669-674. Theiling, B. J., et al. (2020). "A Method for Grouping Emergency Department Visits by Severity and Complexity." The Western Journal of Emergency Medicine 21(5): 1147-1155. Vergara, P., et al. (2021). "Validation of the National Early Warning Score (NEWS)-2 for adults in the emergency department in a tertiary-level clinic in Colombia: Cohort study." Medicine 100(40): e27325-e27325. Villa, S., et al. (2018). "Decreasing triage time: effects of implementing a step-wise ESI algorithm in an EHR." International Journal for Quality in Health Care 30(5): 375-381. Volk, S., et al. (2022). "Patient disposition using the Emergency Severity Index: a retrospective observational study at an interdisciplinary emergency department." BMJ Open 12(5): e057684. Whitfield, C. G. (2013). Emergency department triage acuity ratings: Embedding ESI into the electronic medical record. University of South Carolina. 208 p-208 p. Wolf, L. A. and Delao, A. M. (2021). "Establishing Research Priorities for the Emergency Severity Index Using a Modified Delphi Approach." Journal of Emergency Nursing 47(1): 50-57. Worth, M. G. (2017). "Structure, Process, and Recommendations of Emergency Department Triage in the U.S." Structure, Process & Recommendations of Emergency Department Triage in the U.S: 1-1. Chiang, D., et al. (2021). "Assessment of ED triage of anaphylaxis patients based on the Emergency Severity Index." American Journal of Emergency Medicine 46: 449-455. Kemp, K., et al. (2022). "Accuracy of Emergency Severity Index in older adults." European Journal of Emergency Medicine 29(3): 204-209. Linton, E., et al. (2021). "System Level Informatics to Improve Triage Practices for Sickle Cell Disease Vaso-Occlusive Crisis: A Cluster Randomized Controlled Trial." Journal of Emergency Nursing 47(5): 742-751.e1.

Tool	Full Citations
	Nieves-Ortega, R., et al. (2021). "Assessment of patient mobility improves the risk stratification of triage with the Emergency Severity Index: a prospective cohort study." European Journal of Emergency Medicine 28(6): 456-462. Rueegg, M., et al. (2022). "The clinical frailty scale predicts 1-year mortality in emergency department patients aged 65 years and older." Academic Emergency Medicine 29(5): 572-580. Frisch, S. O., et al. (2020). "The Association Between Patient Outcomes and the Initial Emergency Severity Index Triage Score in Patients With Suspected Acute Coronary Syndrome." Journal of Cardiovascular Nursing 35(6): 550-557. Malinovska, A., et al. (2019). "Modification of the Emergency Severity Index Improves Mortality Prediction in Older Patients." The Western Journal of Emergency Medicine 20(4): 633-640. Abaya, R., et al. (2019). "Improving efficiency of pediatric emergency asthma treatment by using metered dose inhaler." Journal of Asthma 56(10): 1079-1086. Dugas, A. F., et al. (2016). "An Electronic Emergency Triage System to Improve Patient Distribution by Critical Outcomes." 1(6): 910-8. Karlis, G., et al. (2020). "Emergency department visits, emergency severity index and intensive care unit admissions in the era of COVID19;A single center experience." Intensive Care Medicine Experimental 8. Kemp, K., et al. (2022). "Effect of age adjustment on two triage methods." BMC Emergency Medicine 22(1): 52. Rathlev, N. K., et al. (2020). "Patient Characteristics and Clinical Process Predictors of Patients Leaving Without Being Seen from the Emergency Department." Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health 21(5): 1218-1226. Riordan, J. P., et al. (2017). "Can Patient Variables Measured on Arrival to the Emergency Department Predict Disposition in Medium-acuity Patients?" 1(5): 769-779. Simon, E. L., et al. (2015). "A comparison of acuity levels between 3 freestanding and a tertiary care ED." 1(4): 539-41. Torabi, M., et al. (2016). "Shock index, modified shock index, and age shock index for prediction of mortality in Emergency Severity Index level 3." 1(11): 2079-2083. Vigil, J. M., et al. (2016). "Patient Ethnicity Affects Triage Assessments and Patient Prioritization in U.S. Department of Veterans Affairs Emergency Departments." 1(14): e3191. Adler, D., et al. (2019). "Validation of the Emergency Severity Index (Version 4) for the Triage of Adult Emergency Department Patients With Active Cancer." Journal of Emergency Medicine (0736-4679) 57(3): 354-361. Costabel, J. P., et al. (2015). "Triage in cardiovascular emergency services: validity and usefulness of emergency severity index 4." Canadian Journal of Cardiology 31(2): 228.e3-4.

Tool	Full Citations
Estimation of illness severity (EIS)	Andrews, H. and Kass, L. (2018). "Non-urgent use of emergency departments: populations most likely to overestimate illness severity." Internal & Emergency Medicine 13(6): 893-900.
Excess mortality ratio-based Emergency Severity Index (EMR-ESI)	Hong, K. J., et al. (2012). "Development and validation of the excess mortality ratio-based Emergency Severity Index." 1(8): 1491-500.
Expert practitioner	Baimas-George, M., et al. (2022). "Emergency general surgery transfer to lower acuity facility: The role of right-sizing care in emergency general surgery regionalization." The Journal of Trauma and Acute Care Surgery 92(1): 38-43. Cabrera, D., et al. (2015). "Accuracy of 'My Gut Feeling:' Comparing System 1 to System 2 Decision-Making for Acuity Prediction, Disposition and Diagnosis in an Academic Emergency Department." 1(5): 653-7. Hart, A., et al. (2018). "Intuitive versus Algorithmic Triage." Prehospital & Disaster Medicine 33(4): 355-361. Wiswell, J., et al. (2013). "'Sick' or 'not-sick': accuracy of System 1 diagnostic reasoning for the prediction of disposition and acuity in patients presenting to an academic ED." American Journal of Emergency Medicine 31(10): 1448-1452. Napoli, A. M., et al. (2020). "Boarding is Associated with Reduced Emergency Department Efficiency that is not Mitigated by a Provider in Triage." The Western Journal of Emergency Medicine 21(3): 647-652. Herzog, S. M., et al. (2020). "Emergency department patients with weakness or fatigue: Can physicians predict their outcomes at the front door? A prospective observational study." PLoS ONE [Electronic Resource] 15(11): e0239902.
Glasgow Admission Prediction Score (GAPS)	Cameron, A., et al. (2018). "Comparison of Glasgow Admission Prediction Score and Amb Score in predicting need for inpatient care." Emergency Medicine Journal 35(4): 247-251.
Hillerod Acute Process Triage (HAPT) system	Barfod, C., et al. (2012). "Abnormal vital signs are strong predictors for intensive care unit admission and in-hospital mortality in adults triaged in the emergency department - a prospective cohort study." 1: 28.
HOTEL score	Jo, S., et al. (2013). "Modified early warning score with rapid lactate level in critically ill medical patients: the ViEWS-L score." Emergency Medicine Journal 30(2): 123-129.
Identification of Seniors at Risk (ISAR)	Di Bari, M., et al. (2012). "Prognostic stratification of elderly patients in the emergency department: a comparison between the 'identification of seniors at risk' and the 'silver code'." Journals of Gerontology Series A: Biological Sciences & Medical Sciences 67A(5): 544-550.
Illness Rating Score (IRS)	O'Neill, L. B., et al. (2021). ""Sick or not sick?" A mixed methods study evaluating the rapid determination of illness severity in a pediatric emergency department." Diagnosis 9(2): 207-215.
Interagency Integrated Triage Tool	Mitchell, R., et al. (2022). "Emergency department triage and COVID-19: Performance of the Interagency Integrated Triage Tool during a pandemic surge in Papua New Guinea." Emergency Medicine Australasia 34(5): 822-824.

Tool	Full Citations
Japanese Triage and Acuity Scale (JTAS)	Akira Kuriyama, T. I. T. K. T. F. T. N. (2018). "Validity of the Japan Acuity and Triage Scale in adults: a cohort study." Emergency Medicine Journal: 384-388. Hamamoto, J., et al. (2014). "Impacts of the introduction of a triage system in Japan: a time series study." 1(3): 153-8. Takaoka, K., et al. (2021). "Utility of the Emergency Severity Index by Accuracy of Interrater Agreement by Expert Triage Nurses in a Simulated Scenario in Japan: A Randomized Controlled Trial." Journal of Emergency Nursing 47(4): 669-674. Toru Koyama, T. K. M. Y. K. O. T. K. Y. M. (2017). "A study of the effect of introduction of JTAS in the emergency room." Acute medicine & surgery: 262-270. Akira Kuriyama, T. I. T. N. (2019). "Impact of age on the discriminative ability of an emergency triage system: A cohort study." Acta Anaesthesiologica Scandinavica: 781-788. Takahashi, T., et al. (2016). "'Down-triage' for children with abnormal vital signs: evaluation of a new triage practice at a paediatric emergency department in Japan." 1(8): 533-7.
Korean Triage and Acuity Scale (KTAS)	Hyuksool Kwon, Y. J. K. Y. H. J. J. H. L. J. H. L. J. K. J. E. H. J. J. Y. J. C. (2019). "The Korean Triage and Acuity Scale: associations with admission, disposition, mortality and length of stay in the emergency department." International Journal for Quality in Health Care: 449-455. J. H, H., et al. (2019). "A Study of the Korea Triage and Acuity Scale Using National Emergency Department Information System Analysis...10th Mediterranean Emergency Medicine Congress, 22-25 September, 2019, Dubrovnik, Croatia." Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health 20: S11-S11. Moon, S. H., et al. (2019). "Triage accuracy and causes of mistriage using the Korean Triage and Acuity Scale." PLoS ONE [Electronic Resource] 14(9): e0216972. Ryu, J. H., et al. (2019). "Changes in Relative Importance of the 5-Level Triage System, Korean Triage and Acuity Scale, for the Disposition of Emergency Patients Induced by Forced Reduction in Its Level Number: a Multi-Center Registry-based Retrospective Cohort Study." Journal of Korean Medical Science 34(14): e114. Yu, J. Y., et al. (2022). "An external validation study of the Score for Emergency Risk Prediction (SERP), an interpretable machine learning-based triage score for the emergency department." Scientific Reports 12(1): 17466. Lim, Y. D., et al. (2020). "Validity of the Korean Triage and Acuity Scale for predicting 30-day mortality due to severe trauma: a retrospective single-center study." European Journal of Trauma & Emergency Surgery 46(4): 895-901. Jung, H. M., et al. (2021). "The effect of overcrowding in emergency departments on the admission rate according to the emergency triage level." PLoS ONE [Electronic Resource] 16(2): e0247042. Kim, H. J., et al. (2021). "Development of a Web-Based Korean Triage and Acuity Scale Learning Program for Emergency Department Nurses." CIN: Computers, Informatics, Nursing 39(11): 821-827.

Tool	Full Citations
	Ji Hwan Lee, Y. S. P. I. C. P. H. S. L. J. H. K. J. M. P. S. P. C. M. J. K. (2019). "Over-triage occurs when considering the patient's pain in Korean Triage and Acuity Scale (KTAS)." PLoS ONE: e0216519.
Machine-learning risk prediction models (AI models)	Anonymous (2020). "Using machine-learning risk prediction models to triage the acuity of undifferentiated patients entering the emergency care system: a systematic review." Diagnostic and prognostic research. Chang, Y.-H., et al. (2022). "Machine learning-based triage to identify low-severity patients with a short discharge length of stay in emergency department." BMC Emergency Medicine 22(1): 1-10. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Kareemi, H., et al. (2021). "Machine Learning Versus Usual Care for Diagnostic and Prognostic Prediction in the Emergency Department: A Systematic Review." Academic Emergency Medicine 28(2): 184-196. Lee, J. T., et al. (2021). "Prediction of hospitalization using artificial intelligence for urgent patients in the emergency department." Scientific Reports 11(1): 19472. Levin, S., et al. (2018). "Machine-Learning-Based Electronic Triage More Accurately Differentiates Patients With Respect to Clinical Outcomes Compared With the Emergency Severity Index." Annals of Emergency Medicine 71(5): 565-574.e2. Naemi, A., et al. (2020). "Personalized Predictive Models for Identifying Clinical Deterioration Using LSTM in Emergency Departments." Studies in Health Technology & Informatics 275: 152-156. Nguyen, M., et al. (2021). "Developing machine learning models to personalize care levels among emergency room patients for hospital admission." Journal of the American Medical Informatics Association 28(11): 2423-2432. Raita, Y., et al. (2019). "Emergency department triage prediction of clinical outcomes using machine learning models." Critical Care (London, England) 23(1): 64. Rendell, K., et al. (2019). "The Sydney Triage to Admission Risk Tool (START2) using machine learning techniques to support disposition decision-making." Emergency Medicine Australasia 31(3): 429-435. Sanchez-Salmeron, R., et al. (2022). "Machine learning methods applied to triage in emergency services: A systematic review." International emergency nursing 60: 101109. van Doorn, W. P. T. M., et al. (2021). "Explainable Machine Learning models for Rapid Risk Stratification in the Emergency Department: A multi-center study." medRxiv: 2020.11.25.20238386. Wang, S. T. (2013). "Construct an optimal triage prediction model: a case study of the emergency department of a teaching hospital in Taiwan." 1(5): 9968. Wunsch, G., et al. (2017). "A Semantic-Based Model for Triage Patients in

Tool	Full Citations
	Emergency Departments." 1(4): 65. Yao, L. H., et al. (2021). "A Novel Deep Learning-Based System for Triage in the Emergency Department Using Electronic Medical Records: Retrospective Cohort Study." Journal of Medical Internet Research 23(12): e27008. Yu, J. Y., et al. (2022). "An external validation study of the Score for Emergency Risk Prediction (SERP), an interpretable machine learning-based triage score for the emergency department." Scientific Reports 12(1): 17466. Zlotnik, A., et al. (2016). "Building a Decision Support System for Inpatient Admission Prediction With the Manchester Triage System and Administrative Check-in Variables." CIN: Computers, Informatics, Nursing 34(5): 224-230. Zmiri, D., et al. (2012). "Classification of patients by severity grades during triage in the emergency department using data mining methods." Journal of Evaluation in Clinical Practice 18(2): 378-388.
Manchester Triage System (MTS)	Akira Kuriyama, S. U. T. N. (2017). "Five-level emergency triage systems: variation in assessment of validity." Emergency Medicine Journal: 703-710. Azeredo, T. R., et al. (2015). "Efficacy of the Manchester Triage System: a systematic review." International emergency nursing 23(2): 47-52. Beck, N., et al. (2022). "The Manchester Triage System in a Pediatric Emergency Department of an Austrian University Hospital: A Retrospective Analysis of Urgency Levels." Pediatric Emergency Care 38(2): e639-e643. Cicolo, E. A., et al. (2020). "Effectiveness of the Manchester Triage System on time to treatment in the emergency department: a systematic review." JBI Evidence Synthesis 18(1): 56-73. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Gaumont, D., et al. (2016). "ViEWS from the prehospital perspective: a comparison with a prehospital score to triage categorisation in the emergency department." 1(6): 423. Joany M Zachariasse, N. S. P. P. M. R. C. F. A. P. F. F. J. S. G. R. R. H. A. M. (2017). "Validity of the Manchester Triage System in emergency care: A prospective observational study." PLoS ONE: e0170811. Joany M Zachariasse, V. v. d. H. N. S. K. M.-J. M. v. V. H. A. M. (2019). "Performance of triage systems in emergency care: a systematic review and meta-analysis." BMJ open: e026471. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227.

Tool	Full Citations
	McCabe, C., et al. (2019). "The introduction of the Early Warning Score in the Emergency Department: A retrospective cohort study." International emergency nursing 45: 31-35. Mirhaghi, A., et al. (2017). "The reliability of the Manchester Triage System (MTS): a meta-analysis." 1(2): 129-135. Möckel, M., et al. (2020). "["Triage"-primary assessment of patients in the emergency department : An overview with a systematic review]." Medizinische Klinik, Intensivmedizin und Notfallmedizin 115(8): 668-681. Mota Guedes, H., et al. (2017). "Outcome assessment of patients classified through the Manchester Triage System in emergency units in Brazil and Portugal." Investigacion & Educacion en Enfermeria 35(2): 174-181. Nicola Parenti, M. L. B. R. P. I. D. P. D. D. (2014). "A systematic review on the validity and reliability of an emergency department triage scale, the Manchester Triage System." International journal of nursing studies: 1062-9. Santos, A. P., et al. (2014). "Manchester triage system version II and resource utilisation in the emergency department." Emergency Medicine Journal 31(2): 148-152. Souza, C. C., et al. (2015). "[Scientific Literature on the Reliability and Validity of the Manchester Triage System (MTS) Protocol: A Integrative Literature Review]." Revista da Escola de Enfermagem da U S P 49(1): 144-51. Steiner, D., et al. (2016). "Performance of the Manchester Triage System in Adult Medical Emergency Patients: A Prospective Cohort Study." 1(4): 678-89. van der Straten, L. M., et al. (2012). "Safety and efficiency of triaging low urgent self-referred patients to a general practitioner at an acute care post: an observational study." 1(11): 877-81. Vredebregt, S. J., et al. (2019). "Recognizing critically ill children with a modified pediatric early warning score at the emergency department, a feasibility study." European Journal of Pediatrics 178(2): 229-234. Zlotnik, A., et al. (2016). "Building a Decision Support System for Inpatient Admission Prediction With the Manchester Triage System and Administrative Check-in Variables." CIN: Computers, Informatics, Nursing 34(5): 224-230. Anna Slagman, F. G. J. S. L. H. F. T. J. F. M. B. T. L. M. M. (2019). "Suitability of the German version of the Manchester Triage System to redirect emergency department patients to general practitioner care: a prospective cohort study." BMJ open: e024896. Ausserhofer, D., et al. (2020). "Performance of the Manchester Triage System in patients with dyspnoea: A retrospective observational study." International emergency nursing 53: 100931. Ayache Nishi, F., et al. (2017). "Assessing sensitivity and specificity of the Manchester Triage System in the evaluation of acute coronary syndrome in adult patients in emergency care: a systematic review." JBI Database of Systematic Reviews & Implementation Reports 15(6): 1747-1761.

Tool	Full Citations
	Brigo, F., et al. (2022). "The Manchester Triage System's performance in clinical risk prioritisation of patients presenting with headache in emergency department: A retrospective observational study." Journal of Clinical Nursing 31(17-18): 2553-2561. Brouns, S. H. A., et al. (2019). "Performance of the Manchester triage system in older emergency department patients: a retrospective cohort study." BMC Emergency Medicine 19(1): 3. Fernanda A Nishi, C. P. D. d. A. L. M. d. C. (2018). "Sensitivity and specificity of the Manchester Triage System in risk prioritization of patients with acute myocardial infarction who present with chest pain." European Journal of Cardiovascular Nursing: 660-666. Fistera, D., et al. (2020). "Separating the wheat from the chaff-COVID-19 in a German emergency department: a case-control study." International journal of emergency medicine 13(1): 44. Joany M Zachariasse, J. W. K. M. d. H. H. A. M. M. v. V. (2016). "Safety of the Manchester Triage System to Detect Critically Ill Children at the Emergency Department." Journal of Pediatrics: 232-237.e1. Lucke, J. A., et al. (2022). "Mortality risk for different presenting complaints amongst older patients assessed with the Manchester triage system." European Geriatric Medicine 13(2): 323-328. Mirjam van Veen, E. W. S. M. V. t. K. M. R. A. H. J. v. M. J. v. d. L. H. A. M. (2012). "The Manchester triage system: improvements for paediatric emergency care." Emergency Medicine Journal: 654-9. Miro, O., et al. (2016). "Short-term predictive capacity of two different triage systems in patients with acute heart failure: TRICA-EAHFE study." 1(6): 435-441. Monteiro Pereira, M. S., et al. (2017). "Association between the Manchester Triage System and the final outcome in stroke patients." Revista de Enfermagem Referência 4(13): 93-102. Paiva, L., et al. (2012). "Manchester triage in acute pulmonary embolism: can it unmask the grand impersonator?" 1(12): e6. Pearce, L. (2022). "How the Manchester Triage System helps service users: This clinical tool ensures parity of care for people in mental health crises presenting to the emergency department." Mental Health Practice 25(1): 10-10. Zaboli, A., et al. (2020). "Effectiveness of Manchester Triage System in risk prioritisation of patients with pulmonary embolism who present dyspnoea, chest pain or collapse." International emergency nursing 50: 100842. Zaboli, A., et al. (2020). "Triage of patients with fever: The Manchester triage system's predictive validity for sepsis or septic shock and seven-day mortality." Journal of Critical Care 59: 63-69. Zaboli, A., et al. (2021). "Acute abdominal pain in triage: A retrospective observational study of the Manchester triage system's validity." Journal of Clinical Nursing 30(7-8): 942-951.

Tool	Full Citations
	Zaboli, A., et al. (2022). "Triage assessment of transitory loss of consciousness in the emergency department-A retrospective observational study." Journal of Advanced Nursing 78(5): 1337-1347. Zachariasse, J. M., et al. (2021). "Improving the prioritization of children at the emergency department: Updating the Manchester Triage System using vital signs." PLoS ONE [Electronic Resource] 16(2): e0246324. Alen Coutinho, I., et al. (2020). "Anaphylaxis in an emergency department: a retrospective 10-year study in a tertiary hospital." European Annals of Allergy & Clinical Immunology 52(1): 23-34. Madanelo, M., et al. (2020). "The impact of the coronavirus disease 2019 pandemic on the utilisation of emergency urological services." BJU International 126(2): 256-258. Martins, B. and Filipe, L. (2020). "Doctors' response to queues: Evidence from a Portuguese emergency department." Health Economics 29(2): 123-137. Martins, J. C. A., et al. (2017). "Association between vital signs and Manchester Triage System: a retrospective observational study." Online Brazilian Journal of Nursing 16(4): 1-1. Mirjam van Veen, F. t. W. M. J. P. M. R. A. H. J. v. M. C. H. E. W. S. H. A. M. (2012). "Referral of nonurgent children from the emergency department to general practice: compliance and cost savings." European Journal of Emergency Medicine: 14-9. Nonnenmacher, C. L., et al. (2018). "Factors that influence care priority for chest pain patients using the manchester triage system." Journal of Clinical Nursing (John Wiley & Sons, Inc.) 27(5-6): e940-e950. O'Callaghan, M., et al. (2019). "335 GEMS: Geriatric Emergency Service Emergency Triage and Older People with Frailty...67th Annual & Scientific Meeting of the Irish Gerontological Society, Innovation, Advances and Excellence in Ageing, 26–28 September 2019, Cork, Ireland." Age & Ageing 48: iii17-iii65. Pearce, L. (2022). "Managing people in mental health crises with the Manchester Triage System: This crucial clinical tool ensures parity of care for anyone presenting to the emergency department." Emergency Nurse 30(1): 10-11. Pemmerl, S. and Hüfner, A. (2021). "[Epidemiology, initial diagnosis, and therapy of unexplained abdominal pain in the emergency department]." Medizinische Klinik, Intensivmedizin und Notfallmedizin 116(7): 578-585. Rose, K., et al. (2020). "Paediatric Attendances and Acuity in the Emergency Department during the COVID-19 Pandemic." medRxiv: 2020.08.05.20168666. Simon Leigh, A. G. N. M. B. F. H. D. S. D. N. C. J. B. M. Y. R. S. S. K. E. J. D. B. M. S. Y. F. C. (2019). "The cost of diagnostic uncertainty: a prospective economic analysis of febrile children attending an NHS emergency department." BMC Medicine: 48. Smith, L., et al. (2018). "To GP or not to GP: a natural experiment in children triaged to see a GP in a tertiary paediatric emergency department (ED)." BMJ Quality & Safety 27(7): 521-528.

Tool	Full Citations
	Leite, L., et al. (2015). "Chest pain in the emergency department: risk stratification with Manchester triage system and HEART score." 1: 48. Jayaweera, D., et al. (2014). "A comparison of emergency triage scales in triaging poisoned patients." 1(4): 184-9. Balossini, V., et al. (2013). "Triage of children with headache at the ED: a guideline implementation study." American Journal of Emergency Medicine 31(4): 670-675. Gonçalves, S. M., et al. (2018). "Effectiveness to identify acute myocardial infarction using the Manchester screening in patients with chest pain at the emergency service." Journal of Clinical Laboratory Analysis 32(6): 1-1. Graff, I., et al. (2014). "The German Version of the Manchester Triage System and its quality criteria--first assessment of validity and reliability." 1(2): e88995. Graff, I., et al. (2017). "Validity of the Manchester Triage System in patients with sepsis presenting at the ED: a first assessment." 1(4): 212-218. Graff, I., et al. (2019). "Validity of the Manchester Triage System in emergency patients receiving life-saving intervention or acute medical treatment-A prospective observational study in the emergency department." Journal of Evaluation in Clinical Practice 25(3): 398-403. Kiblboeck, D., et al. (2020). "Evaluation of the Manchester triage system for patients with acute coronary syndrome." Wiener Klinische Wochenschrift 132(11-12): 277-282. Leeb, F., et al. (2022). "Improving the safety of the Manchester triage system for children with congenital heart disease." European Journal of Pediatrics 181(11): 3831-3838. Seiger, N., et al. (2013). "Accuracy of triage for children with chronic illness and infectious symptoms." 1(6): e1602-8. Seiger, N., et al. (2014). "Improving the Manchester Triage System for pediatric emergency care: an international multicenter study." 1(1): e83267. van Ierland, Y., et al. (2013). "Alarming signs in the Manchester triage system: a tool to identify febrile children at risk of hospitalization." 1(4): 862-866.e3.
Medical Priority Dispatch System (MPDS)	Andrew, E., et al. (2019). "Aligning ambulance dispatch priority to patient acuity: A methodology." Emergency Medicine Australasia 31(3): 405-410. Clawson, J. J., et al. (2016). "Predictive Ability of an Emergency Medical Dispatch Stroke Diagnostic Tool in Identifying Hospital-Confirmed Strokes." Journal of Stroke & Cerebrovascular Diseases 25(8): 2031-2042.
Modified Early Warning Score (MEWS)	Bulut, M., et al. (2014). "The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department." Emergency Medicine Journal 31(6): 476-481. Griffiths, J. R., et al. (2012). "Current use of early warning scores in UK emergency departments." Emergency Medicine Journal 29(1): 65-66. J. H, H., et al. (2019). "A Study of the Korea Triage and Acuity Scale Using National

Tool	Full Citations
	Emergency Department Information System Analysis...10th Mediterranean Emergency Medicine Congress, 22-25 September, 2019, Dubrovnik, Croatia." Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health 20: S11-S11. Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696. So, S. N., et al. (2015). "Is the Modified Early Warning Score able to enhance clinical observation to detect deteriorating patients earlier in an Accident & Emergency Department?" 1(1): 24-32. Wong, Y. K., et al. (2016). "Prediction of en-route complications during interfacility transport by outcome predictive scores in ED." American Journal of Emergency Medicine 34(5): 877-882. Geier, F., et al. (2013). "Severity illness scoring systems for early identification and prediction of in-hospital mortality in patients with suspected sepsis presenting to the emergency department." 1(17-18): 508-15. Gangemi, A. J., et al. (2021). "Utility of a Clinical Scoring System for Point of Care Triaging in COVID-19 Pneumonia." medRxiv: 2021.02.26.21252256.
Modified early warning score with rapid lactate level (ViEWS-L)	Cetinkaya, H. B., et al. (2017). "The predictive value of the modified early warning score with rapid lactate level (ViEWS-L) for mortality in patients of age 65 or older visiting the emergency department." 1(8): 1253-1257.
Modified emergency severity index (mESI)	Lipe, D. N., et al. (2022). "A modified emergency severity index level is associated with outcomes in cancer patients with COVID-19." American Journal of Emergency Medicine 54: 111-116.
Modified Japanese Triage and Acuity Scale (mJTAS)	Hiraku, F., et al. (2016). "Validation of the modified Japanese Triage and Acuity Scale-based triage system emphasizing the physiologic variables or mechanism of injuries." International Journal of Emergency Medicine 9: 1-6.
Modified Korean Triage and Acuity Scale	Choi, D. H., et al. (2021). "Modification and Validation of a Complaint-Oriented Emergency Department Triage System: A Multicenter Observational Study." Yonsei Medical Journal 62(12): 1145-1154.
Modified Paediatric Early Warning Score (mPEWS)	Vredebregt, S. J., et al. (2019). "Recognizing critically ill children with a modified pediatric early warning score at the emergency department, a feasibility study." European Journal of Pediatrics 178(2): 229-234.
Modified Rapid Emergency Medicine Score (mREMS)	Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606. Martin-Rodriguez, F., et al. (2021). "Early warning scores in patients with suspected covid-19 infection in emergency departments." J. Pers. Med. 11(3): 1-13.
Multiple Organ Dysfunction Score (MODS)	Anonymous (2018). "Comparison of various severity assessment scoring systems in patients with sepsis in a tertiary care teaching hospital." Indian Journal of Critical Care Medicine 22(12): 842-845.
National Early Warning Score	Alam, N., et al. (2015). "Exploring the performance of the National Early Warning

Tool	Full Citations
(NEWS)	Score (NEWS) in a European emergency department." 1: 111-5. Kivipuro, M., et al. (2018). "National early warning score (NEWS) in a Finnish multidisciplinary emergency department and direct vs. late admission to intensive care." Resuscitation 128: 164-169. Carlos Echevarria, J. S. S. C. B. (2019). "Comparison of early warning scores in patients with COPD exacerbation: DECAF and NEWS score." Thorax: 941-946. Gangemi, A. J., et al. (2021). "Utility of a Clinical Scoring System for Point of Care Triaging in COVID-19 Pneumonia." medRxiv: 2021.02.26.21252256. Corfield, A. R., et al. (2014). "Utility of a single early warning score in patients with sepsis in the emergency department." Emergency Medicine Journal 31(6): 482-487. Dominic, C., et al. (2021). "Missed opportunities to use rapid influenza testing and severity assessment to avoid hospital admission: A cohort study from an East London District General Hospital." Journal of Medical Virology 93(6): 3934-3938. Keep, J. W., et al. (2016). "National early warning score at Emergency Department triage may allow earlier identification of patients with severe sepsis and septic shock: a retrospective observational study." 1(1): 37-41. Cattermole, G. N., et al. (2014). "THERM: the Resuscitation Management score. A prognostic tool to identify critically ill patients in the emergency department." Emergency Medicine Journal 31(10): 803-807. Oduncu, A. F., et al. (2021). "Comparison of qSOFA, SIRS, and NEWS scoring systems for diagnosis, mortality, and morbidity of sepsis in emergency department." American Journal of Emergency Medicine 48: 54-59.
National Early Warning Score 2 (NEWS2)	Martin-Rodriguez, F., et al. (2019). "Analysis of the early warning score to detect critical or high-risk patients in the prehospital setting." Internal & Emergency Medicine 14(4): 581-589. Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606. Masson, H. and Stephenson, J. (2022). "Investigation into the predictive capability for mortality and the trigger points of the National Early Warning Score 2 (NEWS2) in emergency department patients." Emergency Medicine Journal 39(9): 685-690. Vergara, P., et al. (2021). "Validation of the National Early Warning Score (NEWS)-2 for adults in the emergency department in a tertiary-level clinic in Colombia: Cohort study." Medicine 100(40): e27325-e27325. Carlos Echevarria, J. S. S. C. B. (2019). "Comparison of early warning scores in patients with COPD exacerbation: DECAF and NEWS score." Thorax: 941-946. Martin-Rodriguez, F., et al. (2021). "Early warning scores in patients with suspected covid-19 infection in emergency departments." J. Pers. Med. 11(3): 1-13. Marincowitz, C., et al. (2021). "Prognostic accuracy of triage tools for adults with

Tool	Full Citations
	suspected COVID-19 in a pre-hospital setting: an observational cohort study." medRxiv: 2021.07.27.21261031. Colussi, G., et al. (2021). "Prognostic scores and early management of septic patients in the emergency department of a secondary hospital: results of a retrospective study." BMC Emergency Medicine 21(1): 152. Bradley, P., et al. (2020). "The utility of established prognostic scores in COVID-19 hospital admissions: a multi-centre prospective evaluation of CURB-65, NEWS2, and qSOFA." medRxiv: 2020.07.15.20154815. Sivayoham, N., et al. (2021). "An observational cohort study of the performance of the REDS score compared to the SIRS criteria, NEWS2, CURB65, SOFA, MEDS and PIRO scores to risk-stratify emergency department suspected sepsis." Annals of Medicine 53(1): 1863-1874. Thomas, B., et al. (2021). "Prognostic accuracy of emergency department triage tools for adults with suspected COVID-19: the PRIEST observational cohort study." Emergency Medicine Journal 38(8): 587-593. Alhmoud, B., et al. (2022). "Performance of digital Early Warning Score (NEWS2) in a cardiac specialist setting: retrospective cohort study." medRxiv: 2022.06.09.22275676. Carr, E., et al. (2020). "Evaluation and Improvement of the National Early Warning Score (NEWS2) for COVID-19: a multi-hospital study." medRxiv: 2020.04.24.20078006. Carr, E., Bendayan, R., Bean, D. *et al.* Evaluation and improvement of the National Early Warning Score (NEWS2) for COVID-19: a multi-hospital study. *BMC Med* **19**, 23 (2021). https://doi.org/10.1186/s12916-020-01893-3 Baker, K. F., et al. (2021). "National Early Warning Score 2 (NEWS2) to identify inpatient COVID-19 deterioration: a retrospective analysis." Clinical medicine (London, England) 21(2): 84-89. Euden, J., et al. (2022). "PROcalcitonin and NEWS2 evaluation for Timely identification of sepsis and Optimal use of antibiotics in the emergency department (PRONTO): protocol for a multicentre, open-label, randomised controlled trial." BMJ Open 12(6): e063424. Giuseppe Vittorio De Socio, A. G. F. S. M. P. D. F. (2021). "National Early Warning Score 2 (NEWS2) better predicts critical Coronavirus Disease 2019 (COVID-19) illness than COVID-GRAM, a multi-centre study." EvidenceUpdates: 1033-1038. Kemp, K., et al. (2020). "National Early Warning Score 2 (NEWS2) and 3-level triage scale as risk predictors in frail older adults in the emergency department." BMC Emergency Medicine 20(1): N.PAG-N.PAG. Marius Myrstad, H. I.-H. A. A. T. E. L. A. S. N. A. T. T. B. (2020). "National Early Warning Score 2 (NEWS2) on admission predicts severe disease and in-hospital mortality from Covid-19 - a prospective cohort study." Scandinavian journal of trauma, resuscitation and emergency medicine: 66. Martin-Rodriguez, F., et al. (2019). "Accuracy of National Early Warning Score 2

Tool	Full Citations
	(NEWS2) in Prehospital Triage on In-Hospital Early Mortality: A Multi-Center Observational Prospective Cohort Study." Prehospital & Disaster Medicine 34(6): 610-618. Mohammed, M. A., et al. (2019). "The inclusion of delirium in version 2 of the National Early Warning Score will substantially increase the alerts for escalating levels of care: findings from a retrospective database study of emergency medical admissions in two hospitals." Clinical Medicine 19(2): 104-108. Aleksander Rygh Holten, K. G. N. C. E. V. W. K. T. T. M. O. K. T. (2020). "Predicting severe COVID-19 in the Emergency Department." EvidenceUpdates: 100042. Mellhammar, L., et al. (2019). "NEWS2 is Superior to qSOFA in Detecting Sepsis with Organ Dysfunction in the Emergency Department." Journal of clinical medicine 8(8). Faure, V., et al. (2021). "NEWS-2 Score Assessment of Inpatient Referral during the COVID 19 Epidemic." medRxiv: 2021.06.10.21254528. Durantez-Fernandez, C., et al. (2022). "Lactate improves the predictive ability of the National Early Warning Score 2 in the emergency department." Australian Critical Care 35(6): 677-683. Wallgren, U. M., et al. (2021). "Performance of NEWS2, RETTS, clinical judgment and the Predict Sepsis screening tools with respect to identification of sepsis among ambulance patients with suspected infection: a prospective cohort study." Scandinavian Journal of Trauma, Resuscitation & Emergency Medicine 29(1): 144. Kai Zhang, X. Z. W. D. N. X. B. T. T. H. Z. Z. W. C. H. H. G. Z. (2021). "The Prognostic Accuracy of National Early Warning Score 2 on Predicting Clinical Deterioration for Patients With COVID-19: A Systematic Review and Meta-Analysis." EvidenceUpdates: 699880. Faure, V., et al. (2021). "NEWS-2 Score Assessment of Inpatient Referral during the COVID 19 Epidemic." medRxiv: 2021.06.10.21254528.
Netherlands Triage System (NTS)	Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696. Smits, M., et al. (2022). "Reliability and validity of the Netherlands Triage Standard in emergency care settings: a case scenario study." Emergency Medicine Journal 39(8): 623-627.
Objectified Korean Triage and Acuity Scale (OTAS)	Kim, S. W., et al. (2022). "Development and Validation of Simple Age-Adjusted Objectified Korean Triage and Acuity Scale for Adult Patients Visiting the Emergency Department." Yonsei Medical Journal 63(3): 272-281.
Ohio Department of Public Safety statewide geriatric triage criteria	Caterino, J. M., et al. (2016). "Effect of Geriatric-Specific Trauma Triage Criteria on Outcomes in Injured Older Adults: A Statewide Retrospective Cohort Study." Journal of the American Geriatrics Society 64(10): 1944-1951.
Ohio's 2009 emergency medical services (EMS) geriatric trauma triage criteria	Ichwan, B., et al. (2015). "Geriatric-specific triage criteria are more sensitive than standard adult criteria in identifying need for trauma center care in injured older adults." 1(1): 92-100.e3.

Tool	Full Citations
Paediatric Assessment Triangle (PAT)	Fernandez, A., et al. (2017). "The Validity of the Pediatric Assessment Triangle as the First Step in the Triage Process in a Pediatric Emergency Department." 1(4): 234-238. Horeczko, T., et al. (2013). "The Pediatric Assessment Triangle: Accuracy of Its Application by Nurses in the Triage of Children." Journal of Emergency Nursing 39(2): 182-189. Paniagua, N., et al. (2017). "Initial Asthma Severity Assessment Tools as Predictors of Hospitalization." Journal of Emergency Medicine (0736-4679) 53(1): 10-17.
Paediatric Canadian Triage and Acuity Scale (PedCTAS)	Allon, R., et al. (2018). "Validity of the Pediatric Canadian Triage Acuity Scale in a tertiary children's hospital in Israel." European Journal of Emergency Medicine 25(4): 270-273. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Holt, T., et al. (2018). "The Canadian Paediatric Triage and Acuity Scale algorithm for interfacility transport." American Journal of Disaster Medicine 13(1): 57-63. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227. Arroabarren, E., et al. (2021). "Quality of the Triage of Children With Anaphylaxis at the Emergency Department." Pediatric Emergency Care 37(1): 17-22. Ukiyama, E., et al. (2012). "Pediatric surgery triage: problems and improvements." 1(4): 501-3. Levy, N., et al. (2022). "Triage performance in adolescent patients with SARS-CoV-2 infection in Israel." American Journal of Emergency Medicine 59: 70-73. Morgan Thorn Yates, T. I. A. S. M. B. (2016). "Pediatric Canadian Triage and Acuity Scale (PaedsCTAS) as a Measure of Injury Severity." International journal of environmental research and public health.
Paediatric Early Warning Score (PEWS)	Breslin, K., et al. (2014). "Pediatric early warning score at time of emergency department disposition is associated with level of care." 1(2): 97-103. Lillitos, P. J., et al. (2016). "Can paediatric early warning scores (PEWS) be used to guide the need for hospital admission and predict significant illness in children presenting to the emergency department? An assessment of PEWS diagnostic accuracy using sensitivity and specificity." Emergency Medicine Journal 33(5): 329-337. McElroy, T., et al. (2019). "Implementation study of a 5-component pediatric early warning system (PEWS) in an emergency department in British Columbia, Canada, to inform provincial scale up." BMC Emergency Medicine 19(1): 74. Niu, X., et al. (2016). "Feasibility and Reliability of Pediatric Early Warning Score in the Emergency Department." 1(2): 161-6. Zachariasse, J. M., et al. (2020). "Development and validation of a Paediatric Early

Tool	Full Citations
	Warning Score for use in the emergency department: a multicentre study." The Lancet Child & Adolescent Health 4(8): 583-591. Gardiner, M. A., et al. (2022). "Evaluation of a Pediatric Early Warning Score as a Predictor of Occult Invasive Bacterial Infection in the Pediatric Emergency Department." Pediatric Emergency Care 38(5): 195-200. Page-Goertz, C. K., et al. (2018). "Correlation of Bedside Pediatric Early Warning System Score to Interventions During Peritransport Period." Pediatric Critical Care Medicine 19(11): e618-e626.
Paediatric Observation Priority Score (POPS)	Langton, L., et al. (2018). "Inter-rater reliability in the Paediatric Observation Priority Score (POPS)." Archives of Disease in Childhood 103(5): 458-462. Roland, D., et al. (2017). "Baseline Characteristics of the Paediatric Observation Priority Score in Emergency Departments outside Its Centre of Derivation." 1: 9060852.
Paediatric Sequential Organ Failure Assessment (pSOFA) score	Balamuth, F., et al. (2022). "Validation of the Pediatric Sequential Organ Failure Assessment Score and Evaluation of Third International Consensus Definitions for Sepsis and Septic Shock Definitions in the Pediatric Emergency Department." JAMA Pediatrics 176(7): 672-678.
Paediatric Taiwan Triage and Acuity System (Ped-TTAS)	Chang, Y.-C., et al. (2013). "Effectiveness of a five-level Paediatric Triage System: an analysis of resource utilisation in the emergency department in Taiwan." Emergency Medicine Journal 30(9): 735-739. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Paediatric Taiwan Triage System (Ped-TTS)	Chang, Y.-C., et al. (2013). "Effectiveness of a five-level Paediatric Triage System: an analysis of resource utilisation in the emergency department in Taiwan." Emergency Medicine Journal 30(9): 735-739.
Pandemic Modified Early Warning Score (PMEWS)	Marincowitz, C., et al. (2021). "Prognostic accuracy of triage tools for adults with suspected COVID-19 in a pre-hospital setting: an observational cohort study." medRxiv: 2021.07.27.21261031. Challen, K., et al. (2012). "Evaluation of triage methods used to select patients with suspected pandemic influenza for hospital admission." 1(5): 383-8. Thomas, B., et al. (2021). "Prognostic accuracy of emergency department triage tools for adults with suspected COVID-19: the PRIEST observational cohort study." Emergency Medicine Journal 38(8): 587-593.
Paramedic Pathfinder (PP)	Newton, M., et al. (2014). "Clinical navigation for beginners: the clinical utility and safety of the Paramedic Pathfinder." 1(e1): e29-34.
Perfusion index measurement	Oskay, A., et al. (2015). "Prognosis of Critically Ill Patients in the ED and Value of Perfusion Index Measurement: A Cross-Sectional Study." American Journal of Emergency Medicine 33(8): 1042-1044.
Physician-in-Triage Model	Marshall, J. R., et al. (2017). "Use of Physician-in-Triage Model in the Management of Abdominal Pain in an Emergency Department Observation Unit." 1(2): 181-

Tool	Full Citations
	188.
Pivot triage process (Pivot)	Christensen, M., et al. (2016). "Pivot Nursing: An Alternative to Traditional ED Triage." Journal of Emergency Nursing 42(5): 395-399.
Prehospital National Early Warning Score (Ph-ViEWS)	Gaumont, D., et al. (2016). "ViEWS from the prehospital perspective: a comparison with a prehospital score to triage categorisation in the emergency department." 1(6): 423.
Prehospital National Early Warning Score 2 Lactate (PreNEWS2-L)	Martin-Rodriguez, F., et al. (2019). "Predictive value of the prehospital NEWS2-L - National Early Warning Score 2 Lactate- for detecting early death after an emergency." Emergencias 31(3): 173-179.
Prince of Wales ED Score (PEDS)	Cattermole, G. N., et al. (2014). "THERM: the Resuscitation Management score. A prognostic tool to identify critically ill patients in the emergency department." Emergency Medicine Journal 31(10): 803-807.
Princess Marina Triage Scale (PMTS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Procalcitonin (PCT) and Mid regional pro-Adrenomedullin (MR-proADM)	Travaglino, F., et al. (2012). "Utility of Procalcitonin (PCT) and Mid regional pro-Adrenomedullin (MR-proADM) in risk stratification of critically ill febrile patients in Emergency Department (ED). A comparison with APACHE II score." BMC Infectious Diseases 12(1): 184-184.
Quick Sequential Organ Failure Assessment (qSOFA) score	Kwak, H., et al. (2018). "Prognostic performance of Emergency Severity Index (ESI) combined with qSOFA score." American Journal of Emergency Medicine 36(10): 1784-1788. Martin-Rodriguez, F., et al. (2021). "Early warning scores in patients with suspected covid-19 infection in emergency departments." J. Pers. Med. 11(3): 1-13. Monclus Cols, E., et al. (2018). "Comparison of the Quick Sepsis-related Organ Dysfunction score and severity levels assigned with the Andorran Triage Model in an urban tertiary care hospital emergency department." Emergencias 30(6): 400-404. Finkelsztein, E. J., et al. (2017). "Comparison of qSOFA and SIRS for predicting adverse outcomes of patients with suspicion of sepsis outside the intensive care unit." Critical Care 21: 1-10. Bradley, P., et al. (2020). "The utility of established prognostic scores in COVID-19 hospital admissions: a multi-centre prospective evaluation of CURB-65, NEWS2, and qSOFA." medRxiv: 2020.07.15.20154815. Sterk, E., et al. (2020). "Comparison of an ED triage sepsis screening tool and qSOFA in identifying CMS SEP-1 patients." American Journal of Emergency Medicine 38(10): 1995-1999. Dorsett, M., et al. (2017). "qSOFA Has Poor Sensitivity for Prehospital Identification of Severe Sepsis and Septic Shock." Prehospital Emergency Care 21(4): 489-497. Jiang, L., et al. (2019). "Respiratory adjusted shock index for identifying occult shock and level of Care in Sepsis Patients." American Journal of Emergency

Tool	Full Citations
	Medicine 37(3): 506-509. Nieves Ortega, R., et al. (2019). "Clinical Scores and Formal Triage for Screening of Sepsis and Adverse Outcomes on Arrival in an Emergency Department All-Comer Cohort." Journal of Emergency Medicine 57(4): 453-460.e2. Aleksander Rygh Holten, K. G. N. C. E. V. W. K. T. T. M. O. K. T. (2020). "Predicting severe COVID-19 in the Emergency Department." EvidenceUpdates: 100042. Hunter, C. L., et al. (2018). "Comparing Quick Sequential Organ Failure Assessment Scores to End-tidal Carbon Dioxide as Mortality Predictors in Prehospital Patients with Suspected Sepsis." Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health 19(3): 446-451. Choi, A., et al. (2019). "Prognostic performance of disease severity scores in patients with septic shock presenting to the emergency department." American Journal of Emergency Medicine 37(6): 1054-1059. Mellhammar, L., et al. (2019). "NEWS2 is Superior to qSOFA in Detecting Sepsis with Organ Dysfunction in the Emergency Department." Journal of clinical medicine 8(8). Oduncu, A. F., et al. (2021). "Comparison of qSOFA, SIRS, and NEWS scoring systems for diagnosis, mortality, and morbidity of sepsis in emergency department." American Journal of Emergency Medicine 48: 54-59.
Quick-look triage approach (QLT)	Ahc, M. (2018). "A Deeper Exploration of How ED Nurses Triage." ED Legal Letter 29(12): 0-0. Betz, M., et al. (2016). "A comparison of a formal triage scoring system and a quick-look triage approach." 1(3): 185-9. Iversen, A. K. S., et al. (2019). "A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department." Emergency Medicine Journal 36(2): 66-71.
Ramathibodi Triage System (RTS)	Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227.
Rapid Acute Physiology Score (RAPS)	Martin-Rodriguez, F., et al. (2021). "Early warning scores in patients with suspected covid-19 infection in emergency departments." J. Pers. Med. 11(3): 1-13.
Rapid Emergency Medicine Score (REMS)	Alter, S. M., et al. (2017). "Evaluating clinical care in the prehospital setting: Is Rapid Emergency Medicine Score the missing metric of EMS?" 1(2): 218-221. Bulut, M., et al. (2014). "The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department." Emergency Medicine Journal 31(6): 476-481. Anonymous (2018). "Comparison of various severity assessment scoring systems in patients with sepsis in a tertiary care teaching hospital." Indian Journal of Critical Care Medicine 22(12): 842-845.
Rapid Emergency Triage and	Perez, N., et al. (2016). "The predictive validity of RETTS-HEV as an acuity triage

Tool	Full Citations
Treatment System - Hospital Unit West (RETTS-HEV)	tool in the emergency department of a Danish Regional Hospital." 1(1): 33-7.
Rapid Emergency Triage and Treatment System (RETTS)	Habbouche, S., et al. (2022). "Comparison of the novel WEst coast System for Triage (WEST) with Rapid Emergency Triage and Treatment System (RETTS©): an observational pilot study." International Journal of Emergency Medicine 15(1): 1-10. Wireklint, S. C., et al. (2021). "An updated national survey of triage and triage related work in Sweden: a cross-sectional descriptive and comparative study." Scandinavian Journal of Trauma, Resuscitation & Emergency Medicine 29(1): 89. Wireklint, S. C., et al. (2022). "A longitudinal, retrospective registry-based validation study of RETTS©, the Swedish adult ED context version." Scandinavian Journal of Trauma, Resuscitation & Emergency Medicine 30(1): 27. Mellhammar, L., et al. (2020). "Scores for sepsis detection and risk stratification - construction of a novel score using a statistical approach and validation of RETTS." PLoS ONE [Electronic Resource] 15(2): e0229210. Wallgren, U. M., et al. (2021). "Performance of NEWS2, RETTS, clinical judgment and the Predict Sepsis screening tools with respect to identification of sepsis among ambulance patients with suspected infection: a prospective cohort study." Scandinavian Journal of Trauma, Resuscitation & Emergency Medicine 29(1): 144.
Rapid Emergency Triage and Treatment System-Adult (RETTS-A) triage	Ruge, T., et al. (2020). "Is medical urgency of elderly patients with traumatic brain injury underestimated by emergency department triage?" Upsala Journal of Medical Sciences 125(1): 58-63. Mirhaghi, A. and Christ, M. (2016). "Revision for the Rapid Emergency Triage and Treatment System Adult (RETTS-A) needed?" 1: 55.
Rapid Emergency Triage and Treatment System-paediatrics (RETTS-p)	Magnusson, C., et al. (2018). "Initial assessment, level of care and outcome among children who were seen by emergency medical services: a prospective observational study." Scandinavian Journal of Trauma, Resuscitation & Emergency Medicine 26(1): 88.
Rapid team triage (Rapid team)	Hosking, J., et al. (2014). "Recognising clinical deterioration in emergency department patients." 1(2): 59-67. Shea, S. S. and Hoyt, K. S. (2012). ""RAPID" team triage: one hospital's approach to patient-centered team triage." 1(2): 177-89.
RAT decision-support app	Cleaver, B., et al. (2021). "Evaluation of a new rapid assessment and treatment (RAT) tablet app for Emergency Department (ED) nurses: Is earlier identification of investigations and treatments feasible?" International emergency nursing 55: 100875.
Resuscitation Management score (THERM)	Cattermole, G. N., et al. (2014). "THERM: the Resuscitation Management score. A prognostic tool to identify critically ill patients in the emergency department." Emergency Medicine Journal 31(10): 803-807.
RISKINDEX	van Doorn, W. P. T. M., et al. (2021). "Explainable Machine Learning models for Rapid Risk Stratification in the Emergency Department: A multi-center study." medRxiv: 2020.11.25.20238386.

Tool	Full Citations
Score for Emergency Risk Prediction (SERP)	Yu, J. Y., et al. (2022). "An external validation study of the Score for Emergency Risk Prediction (SERP), an interpretable machine learning-based triage score for the emergency department." Scientific Reports 12(1): 17466.
Senior Streaming Assessment Further Evaluation after Triage (SAFE-T) Zone	Amith Shetty, N. G. K. B. M. V. (2012). "Senior Streaming Assessment Further Evaluation after Triage zone: A novel model of care encompassing various emergency department throughput measures." Emergency medicine Australasia: 374-82.
Sequential Organ Failure Assessment (SOFA) score	Williams, J. M., et al. (2016). "Severity Scores in Emergency Department Patients With Presumed Infection: A Prospective Validation Study." Critical Care Medicine 44(3): 539-547. Colussi, G., et al. (2021). "Prognostic scores and early management of septic patients in the emergency department of a secondary hospital: results of a retrospective study." BMC Emergency Medicine 21(1): 152. Sivayoham, N., et al. (2021). "An observational cohort study of the performance of the REDS score compared to the SIRS criteria, NEWS2, CURB65, SOFA, MEDS and PIRO scores to risk-stratify emergency department suspected sepsis." Annals of Medicine 53(1): 1863-1874. Hwang, S. Y., et al. (2012). "Comparison of the Sequential Organ Failure Assessment, Acute Physiology and Chronic Health Evaluation II scoring system, and Trauma and Injury Severity Score method for predicting the outcomes of intensive care unit trauma patients." American Journal of Emergency Medicine 30(5): 749-753. Seak, C.-J., et al. (2014). "Performance assessment of the Simplified Acute Physiology Score II, the Acute Physiology and Chronic Health Evaluation II score, and the Sequential Organ Failure Assessment score in predicting the outcomes of adult patients with hepatic portal venous gas in the ED." American Journal of Emergency Medicine 32(12): 1481-1484. Anonymous (2018). "Comparison of various severity assessment scoring systems in patients with sepsis in a tertiary care teaching hospital." Indian Journal of Critical Care Medicine 22(12): 842-845.
Severity-Based Stroke Triage Algorithm for Emergency Medical Services	Bogle, B. M., et al. (2017). "Regional Evaluation of the Severity-Based Stroke Triage Algorithm for Emergency Medical Services Using Discrete Event Simulation." 1(10): 2827-2835.
Shock Index (SI)	Kristensen, A. K. B., et al. (2016). "Is Shock Index a Valid Predictor of Mortality in Emergency Department Patients With Hypertension, Diabetes, High Age, or Receipt of β- or Calcium Channel Blockers?" Annals of Emergency Medicine 67(1): 106-113.e6. Dirks Md, N. P. M., et al. (2021). "Utility of Shock Index for Suspected Rupture of Abdominal Aortic Aneurysms." Prehospital Emergency Care 25(4): 496-503. Kocaoğlu, S. and Çetinkaya, H. B. (2021). "Use of age shock index in determining severity of illness in patients presenting to the emergency department with gastrointestinal bleeding." American Journal of Emergency Medicine 47: 274-278. Torabi, M., et al. (2016). "Association of triage time Shock Index, Modified Shock

Tool	Full Citations
	Index, and Age Shock Index with mortality in Emergency Severity Index level 2 patients." 1(1): 63-8.
Simple Prognostic Score (SPS)	Busch, J.-M., et al. (2022). "Validation of a Simple Score for Mortality Prediction in a Cohort of Unselected Emergency Patients." International Journal of Clinical Practice: 1-9.
Simple Triage and Rapid Treatment (START)	Hart, A., et al. (2018). "Intuitive versus Algorithmic Triage." Prehospital & Disaster Medicine 33(4): 355-361. Hong, R., et al. (2015). "Comparison of START triage categories to emergency department triage levels to determine need for urgent care and to predict hospitalization." 1(1): 13-21. Keith P Cross, M. J. P. M. X. C. (2014). "A Better START for Low-acuity Victims: Data-driven Refinement of Mass Casualty Triage." Prehospital emergency care: 272-8. Lin, Y.-K., et al. (2022). "Simple triage and rapid treatment protocol for emergency department mass casualty incident victim triage." American Journal of Emergency Medicine 53: 99-103. Lin, Y. K., et al. (2020). "Comparison between simple triage and rapid treatment and Taiwan Triage and Acuity Scale for the emergency department triage of victims following an earthquake-related mass casualty incident: a retrospective cohort study." World Journal Of Emergency Surgery 15(1): 20. McKee, C. H., et al. (2020). "Comparing the Accuracy of Mass Casualty Triage Systems When Used in an Adult Population." Prehospital Emergency Care 24(4): 515-524.
Simplified Acute Physiology Score II (SAPS II)	Williams, J. M., et al. (2016). "Severity Scores in Emergency Department Patients With Presumed Infection: A Prospective Validation Study." Critical Care Medicine 44(3): 539-547. Seak, C.-J., et al. (2014). "Performance assessment of the Simplified Acute Physiology Score II, the Acute Physiology and Chronic Health Evaluation II score, and the Sequential Organ Failure Assessment score in predicting the outcomes of adult patients with hepatic portal venous gas in the ED." American Journal of Emergency Medicine 32(12): 1481-1484. Colussi, G., et al. (2021). "Prognostic scores and early management of septic patients in the emergency department of a secondary hospital: results of a retrospective study." BMC Emergency Medicine 21(1): 152. Jo, S., et al. (2013). "Modified early warning score with rapid lactate level in critically ill medical patients: the ViEWS-L score." Emergency Medicine Journal 30(2): 123-129.
Simplified Acute Physiology Score III (SAPS III)	Jo, S., et al. (2013). "Modified early warning score with rapid lactate level in critically ill medical patients: the ViEWS-L score." Emergency Medicine Journal 30(2): 123-129.
Soft tissue oxygen saturation (Sto2) measurement	Davis, W. T., et al. (2017). "Soft tissue oxygen saturation to predict admission from the emergency department: A prospective observational study." 1(8): 1111-1117.

Tool	Full Citations
Soterion Rapid Triage System (SRTS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
South African Triage Scale (SATS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Streaming	Amith Shetty, N. G. K. B. M. V. (2012). "Senior Streaming Assessment Further Evaluation after Triage zone: A novel model of care encompassing various emergency department throughput measures." Emergency medicine Australasia: 374-82. Dover, N. (2012). "Caring for patients in the right place at the right time." 1(3): 30-6. Olaussen, A., et al. (2021). "Paramedic streaming upon arrival in emergency department: A prospective study." Emergency Medicine Australasia 33(2): 286-291. Pierce, B. A. and Gormley, D. (2016). "Are Split Flow and Provider in Triage Models in the Emergency Department Effective in Reducing Discharge Length of Stay?" 1(6): 487-491. Smith, B. and Burscough, S. (2015). "Developing a programme of patient 'streaming' in an emergency department." International Journal of Orthopaedic & Trauma Nursing 19(2): 85-91. van der Linden, C., et al. (2012). "Managing patient flow with triage streaming to identify patients for Dutch emergency nurse practitioners." International Emergency Nursing 20(2): 52-57.
Sydney Triage to Admission Risk Tool (START)	Ebker-White, A. A., et al. (2018). "The Sydney Triage to Admission Risk Tool (START): A prospective validation study." Emergency Medicine Australasia 30(4): 511-516. Rendell, K., et al. (2019). "The Sydney Triage to Admission Risk Tool (START2) using machine learning techniques to support disposition decision-making." Emergency Medicine Australasia 31(3): 429-435. Dinh, M. M., et al. (2016). "The Sydney Triage to Admission Risk Tool (START) to predict Emergency Department Disposition: A derivation and internal validation study using retrospective state-wide data from New South Wales, Australia." BMC Emergency Medicine 16: 46-46.
Symptom Assessment Application (SAA)	Cotte, F., et al. (2022). "Safety of Triage Self-assessment Using a Symptom Assessment App for Walk-in Patients in the Emergency Care Setting: Observational Prospective Cross-sectional Study." JMIR MHealth and UHealth 10(3): e32340.
Taiwan Prehospital Triage System (TPTS)	Tsai, L. H., et al. (2017). "Comparison of prehospital triage and five-level triage system at the emergency department." 1(11): 720-725.
Taiwan Triage and Acuity Scale (TTAS)	Chip-Jin Ng, C.-Y. C. J. C.-J. S. S.-L. T. Y.-M. W. C.-H. C. C.-W. K. J.-C. C. K.-H. H. (2019). "Validation of the five-tier Taiwan Triage and Acuity Scale for prehospital

Tool	Full Citations
	use by Emergency Medical Technicians." Emergency Medicine Journal: 472-478. Tsai, L. H., et al. (2017). "Comparison of prehospital triage and five-level triage system at the emergency department." 1(11): 720-725. Sung, S.-F., et al. (2013). "Validity of a computerised five-level emergency triage system for patients with acute ischaemic stroke." Emergency Medicine Journal 30(6): 454-458. Chien, C. Y., et al. (2022). "Using mobility status as a frailty indicator to improve the accuracy of a computerised five-level triage system among older patients in the emergency department." BMC Emergency Medicine 22(1): 86. Lin, P. H., et al. (2022). "Impact of COVID-19 Pandemic on Emergency Department Volume and Acuity in Low Incidence Area: Taiwan's Experience in Three Hospitals." Journal of acute medicine 12(3): 105-112. Tsai, L. H., et al. (2021). "Impact of the Coronavirus Disease 2019 Pandemic on an Emergency Department Service: Experience at the Largest Tertiary Center in Taiwan." Risk management and healthcare policy 14: 771-777. Chuang, J. F., et al. (2016). "Use of the reverse shock index for identifying high-risk patients in a five-level triage system." 1: 12.
Think Frailty	O'Shaughnessy, Í., et al. (2019). "286 Predictors and Outcomes of Older Persons Attending the Emergency Department of a Large Acute Dublin Teaching Hospital...67th Annual & Scientific Meeting of the Irish Gerontological Society, Innovation, Advances and Excellence in Ageing, 26–28 September 2019, Cork, Ireland." Age & Ageing 48: iii17-iii65.
Three-level triage scale (TLTS)	Lam, R. P. K., et al. (2020). "Performance of a three-level triage scale in live triage encounters in an emergency department in Hong Kong." International Journal of Emergency Medicine 13(1): 1-8.
Triage Information Mortality Model (TIMM)	Teubner, D. J. O., et al. (2015). "Model to predict inpatient mortality from information gathered at presentation to an emergency department: The Triage Information Mortality Model (TIMM)." Emergency Medicine Australasia 27(4): 300-306.
Triage level (TL)	Paniagua, N., et al. (2017). "Initial Asthma Severity Assessment Tools as Predictors of Hospitalization." Journal of Emergency Medicine (0736-4679) 53(1): 10-17.
Triage Quality Assessment Software (TQAS)	Varndell, W., et al. (2019). "The use and feasibility of an online software system to support assessment of accuracy and consistency in applying the Australasian Triage Scale." Australasian Emergency Care 22(3): 168-173.
Triage Risk Stratification Tool (TRST)	Cousins, G., et al. (2013). "Adverse outcomes in older adults attending emergency department: systematic review and meta-analysis of the Triage Risk Stratification Tool. [Review]." 1(4): 230-9. Salvi, F., et al. (2016). Predictive validity of different versions of the Triage Risk Screening Tool. Philadelphia, Pennsylvania, Elsevier B.V. 34: 2454-2456.
Triage scoring system (TSS)	Betz, M., et al. (2016). "A comparison of a formal triage scoring system and a quick-look triage approach." 1(3): 185-9.

Tool	Full Citations
Triage Sieve	McKee, C. H., et al. (2020). "Comparing the Accuracy of Mass Casualty Triage Systems When Used in an Adult Population." Prehospital Emergency Care 24(4): 515-524.
Triage through telemedicine	Beyer, A., et al. (2022). "Triage through telemedicine in paediatric emergency care-Results of a concordance study." PLoS ONE [Electronic Resource] 17(5): e0269058.
TriAGe+ (diagnostic score)	Kuroda, R., et al. (2017). "The TriAGe+ Score for Vertigo or Dizziness: A Diagnostic Model for Stroke in the Emergency Department." Journal of Stroke & Cerebrovascular Diseases 26(5): 1144-1153.
Vitalpac Early Warning Score (VEWS)	Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606.
VitalPAC EWS (ViEWS)	Jo, S., et al. (2013). "Modified early warning score with rapid lactate level in critically ill medical patients: the ViEWS-L score." Emergency Medicine Journal 30(2): 123-129.
WEst coast System for Triage (WEST)	Habbouche, S., et al. (2022). "Comparison of the novel WEst coast System for Triage (WEST) with Rapid Emergency Triage and Treatment System (RETTS©): an observational pilot study." International Journal of Emergency Medicine 15(1): 1-10.

Appendix 4: Citations of studies reporting evidence on models/systems/tools

Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227.

Bulut, M., et al. (2014). "The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department." Emergency Medicine Journal 31(6): 476-481.

de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.

Ebrahimi, M., et al. (2020). "Are Pediatric Triage Systems Reliable in the Emergency Department?" Emergency Medicine International Print 2020: 9825730.

Green, N. A., et al. (2012). "Emergency Severity Index version 4: a valid and reliable tool in pediatric emergency department triage." 1(8): 753-7.

Hinson, J. S., et al. (2019). "Triage Performance in Emergency Medicine: A Systematic Review." Annals of Emergency Medicine 74(1): 140-152.

Hong, R., et al. (2015). "Comparison of START triage categories to emergency department triage levels to determine need for urgent care and to predict hospitalization." 1(1): 13-21.

Lam, R. P. K., et al. (2020). "Performance of a three-level triage scale in live triage encounters in an emergency department in Hong Kong." International Journal of Emergency Medicine 13(1): 1-8.

Lee, S. B., et al. (2020). "Emergency Department Triage Early Warning Score (TREWS) predicts in-hospital mortality in the emergency department." American Journal of Emergency Medicine 38(2): 203-210.

Lin, A. W. (2013). "Predictors of admission to hospital of patients triaged as nonurgent using the Canadian Triage and Acuity Scale." CJEM: 353-8.

Ng, et al. (2019). "Validation of the five-tier Taiwan Triage and Acuity Scale for prehospital use by Emergency Medical Technicians." Emergency Medicine Journal: 472-478.

O'Neill, L. B., et al. (2021). ""Sick or not sick?" A mixed methods study evaluating the rapid determination of illness severity in a pediatric emergency department." Diagnosis 9(2): 207-215.

Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696.

Smith, D. T., et al. (2015). "Analyzing the Usability of the 5-Level Canadian Triage and Acuity Scale By Paramedics in the Prehospital Environment." 1(6): 489-95.

Vredebregt, S. J., et al. (2019). "Recognizing critically ill children with a modified pediatric early warning score at the emergency department, a feasibility study." European Journal of Pediatrics 178(2): 229-234.

Wiswell, J., et al. (2013). "'Sick' or 'not-sick': accuracy of System 1 diagnostic reasoning for the prediction of disposition and acuity in patients presenting to an academic ED." American Journal of Emergency Medicine 31(10): 1448-1452.

Zachariasse, et al. (2019). "Performance of triage systems in emergency care: a systematic review and meta-analysis." BMJ open: e026471.

Appendix 5: Citations of studies reporting on how effectiveness of tools has been assessed

Tool	Citations
Algorithmic	Cabrera, D., et al. (2015). "Accuracy of 'My Gut Feeling:' Comparing System 1 to System 2 Decision-Making for Acuity Prediction, Disposition and Diagnosis in an Academic Emergency Department." 1(5): 653-7. Lemke, K. W., et al. (2020). "A revised classification algorithm for assessing emergency department visit severity of populations." American Journal of Managed Care 26(3): 119-125.
Ambulatory Score (Ambs)	Cameron, A., et al. (2018). "Comparison of Glasgow Admission Prediction Score and Amb Score in predicting need for inpatient care." Emergency Medicine Journal 35(4): 247-251.
Australasian Triage Scale (ATS)	Allen, A. R., et al. (2015). "Accuracy and interrater reliability of paediatric emergency department triage." 1(5): 447-52. Alpert, E. A., et al. (2013). "Simulated evaluation of two triage scales in an emergency department in Israel." 1(6): 431-4. Ebrahimi, M., et al. (2015). "The reliability of the Australasian Triage Scale: a meta-analysis." World Journal of Emergency Medicine 6(2): 94-99. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227. Varndell, W., et al. (2019). "The use and feasibility of an online software system to support assessment of accuracy and consistency in applying the Australasian Triage Scale." Australasian Emergency Care 22(3): 168-173.
Canadian Triage and Acuity Scale (CTAS)	Akira Kuriyama, S. U. T. N. (2017). "Five-level emergency triage systems: variation in assessment of validity." Emergency Medicine Journal: 703-710. Amir Mirhaghi, A. H. R. M. M. E. (2015). "The Reliability of the Canadian Triage and Acuity Scale: Meta-analysis." North American journal of medical sciences: 299-305. Daren Lin, A. W. (2013). "Predictors of admission to hospital of patients triaged as nonurgent using the Canadian Triage and Acuity Scale." CJEM: 353-8. Fernandes, C. M., et al. (2013). "Reliability of the Canadian Triage and Acuity Scale: interrater and intrarater agreement from a community and an academic emergency department." 1(4): 227-32. Gravel, J., et al. (2012). "The Canadian Triage and Acuity Scale for children: a prospective multicenter evaluation." 1(1): 71-7.e3. Howlett, M. K. and Atkinson, P. R. (2012). "A method for reviewing the accuracy and reliability of a five-level triage process (canadian triage and acuity scale) in a community emergency department setting: building the crowding measurement infrastructure." Emergency Medicine International Print 2012: 636045. Joany M Zachariasse, et al. (2019). "Performance of triage systems in emergency care: a systematic review and meta-analysis." BMJ open: e026471. Smith, D. T., et al. (2015). "Analyzing the Usability of the 5-Level Canadian Triage and Acuity Scale By Paramedics in the Prehospital Environment." 1(6): 489-95. Trivedi, S., et al. (2021). "A Comparison Between Computer-Assisted Self-Triage by Patients and Triage Performed by Nurses in the Emergency Department." Cureus

Tool	Citations
	13(3): e14002.
Clinical Decision Support System (CDSS)	Bennett, P. and Hardiker, N. (2016). "A Quantitative Study Investigating the Effects of Computerised Clinical Decision Support in the Emergency Department." 1: 53-7.
Danish Emergency Process Triage (DEPT)	Iversen, A. K. S., et al. (2019). "A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department." Emergency Medicine Journal 36(2): 66-71.
Deep-learning-based Triage and Acuity Score (DTAS)	Kwon, J. M., et al. (2018). "Validation of deep-learning-based triage and acuity score using a large national dataset." PLoS ONE [Electronic Resource] 13(10): e0205836.
Echelle Liegeoise d'Index de Severite a l'Admission (ELISA)	Jobe, J., et al. (2014). "Reliability and validity of a new French-language triage algorithm: the ELISA scale." 1(2): 115-20.
Electronic patient self-triage	Dickson, S. J., et al. (2022). "Agreement and validity of electronic patient self-triage (eTriage) with nurse triage in two UK emergency departments: a retrospective study." European Journal of Emergency Medicine 29(1): 49-55. Trivedi, S., et al. (2021). "A Comparison Between Computer-Assisted Self-Triage by Patients and Triage Performed by Nurses in the Emergency Department." Cureus 13(3): e14002.
Emergency Department Triage Early Warning Score (TREWS)	Lee, S. B., et al. (2020). "Emergency Department Triage Early Warning Score (TREWS) predicts in-hospital mortality in the emergency department." American Journal of Emergency Medicine 38(2): 203-210. Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606.
Emergency Severity Index (ESI)	Akira Kuriyama, S. U. T. N. (2017). "Five-level emergency triage systems: variation in assessment of validity." Emergency Medicine Journal: 703-710. Alpert, E. A., et al. (2013). "Simulated evaluation of two triage scales in an emergency department in Israel." 1(6): 431-4. Ashour, O., et al. (2016). "Dynamic patient grouping and prioritization: a new approach to emergency department flow improvement." Health Care Management Science 19(2): 192-205. Bergs, J., et al. (2014). "Evaluating Implementation of the Emergency Severity Index in a Belgian Hospital." Journal of Emergency Nursing 40(6): 592-597. Brosinski, C. M., et al. (2017). "Improving Triage Accuracy: A Staff Development Approach." 1(3): 145-148. Burgess, M. J. (2017). "Implementation Of The Emergency Severity Index (ESL) Triage Tool in an Urgent Care Setting: A DNP Project." Implementation Of The Emergency Severity Index (ESL) Triage Tool in an Urgent Care Setting: A DNP Project: 1-1. Busch, J.-M., et al. (2022). "Validation of a Simple Score for Mortality Prediction in a Cohort of Unselected Emergency Patients." International Journal of Clinical Practice: 1-9. Buschhorn, H. M., et al. (2013). "Emergency medical services triage using the emergency severity index: is it reliable and valid?" 1(5): e55-63. Cairos-Ventura, L. M., et al. (2019). "Validity and Reliability of the Emergency Severity Index in a Spanish Hospital." International Journal of Environmental

Tool	Citations
	Research & Public Health [Electronic Resource] 16(22): 18. Dateo, J. (2013). "What factors increase the accuracy and inter-rater reliability of the Emergency Severity Index among emergency nurses in triaging adult patients?" Journal of Emergency Nursing 39(2): 203-7. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Green, N. A., et al. (2012). "Emergency Severity Index version 4: a valid and reliable tool in pediatric emergency department triage." 1(8): 753-7. Grossmann, F. F., et al. (2012). "At risk of undertriage? Testing the performance and accuracy of the emergency severity index in older emergency department patients." 1(3): 317-25.e3. Hong, R., et al. (2015). "Comparison of START triage categories to emergency department triage levels to determine need for urgent care and to predict hospitalization." 1(1): 13-21. Joany M Zachariasse, et al. (2019). "Performance of triage systems in emergency care: a systematic review and meta-analysis." BMJ open: e026471. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227. Kwak, H., et al. (2018). "Prognostic performance of Emergency Severity Index (ESI) combined with qSOFA score." American Journal of Emergency Medicine 36(10): 1784-1788. Levin, S., et al. (2018). "Machine-Learning-Based Electronic Triage More Accurately Differentiates Patients With Respect to Clinical Outcomes Compared With the Emergency Severity Index." Annals of Emergency Medicine 71(5): 565-574.e2. Mirhaghi, A., et al. (2015). "Reliability of the Emergency Severity Index: Meta-analysis." Sultan Qaboos University medical journal 15(1): e71-7. Mistry, B., et al. (2018). "Accuracy and Reliability of Emergency Department Triage Using the Emergency Severity Index: An International Multicenter Assessment." Annals of Emergency Medicine 71(5): 581-587.e3. Möckel, M., et al. (2020). "["Triage"-primary assessment of patients in the emergency department : An overview with a systematic review]." Medizinische Klinik, Intensivmedizin und Notfallmedizin 115(8): 668-681. Raita, Y., et al. (2019). "Emergency department triage prediction of clinical outcomes using machine learning models." Critical Care (London, England) 23(1): 64. Singer, R. F., et al. (2012). "The use of and satisfaction with the Emergency Severity Index." 1(2): 120-6. Smith, D. T., et al. (2015). "Analyzing the Usability of the 5-Level Canadian Triage and Acuity Scale By Paramedics in the Prehospital Environment." 1(6): 489-95. Takaoka, K., et al. (2021). "Utility of the Emergency Severity Index by Accuracy of Interrater Agreement by Expert Triage Nurses in a Simulated Scenario in Japan: A

Tool	Citations
	Randomized Controlled Trial." Journal of Emergency Nursing 47(4): 669-674. Vergara, P., et al. (2021). "Validation of the National Early Warning Score (NEWS)-2 for adults in the emergency department in a tertiary-level clinic in Colombia: Cohort study." Medicine 100(40): e27325-e27325. Worth, M. G. (2017). "Structure, Process, and Recommendations of Emergency Department Triage in the U.S." Structure, Process & Recommendations of Emergency Department Triage in the U.S: 1-1.
Expert practitioner	Cabrera, D., et al. (2015). "Accuracy of 'My Gut Feeling:' Comparing System 1 to System 2 Decision-Making for Acuity Prediction, Disposition and Diagnosis in an Academic Emergency Department." 1(5): 653-7. Hart, A., et al. (2018). "Intuitive versus Algorithmic Triage." Prehospital & Disaster Medicine 33(4): 355-361. Wiswell, J., et al. (2013). "'Sick' or 'not-sick': accuracy of System 1 diagnostic reasoning for the prediction of disposition and acuity in patients presenting to an academic ED." American Journal of Emergency Medicine 31(10): 1448-1452.
Japanese Triage and Acuity Scale (JTAS)	Akira Kuriyama, T. I. T. K. T. F. T. N. (2018). "Validity of the Japan Acuity and Triage Scale in adults: a cohort study." Emergency Medicine Journal: 384-388. Hamamoto, J., et al. (2014). "Impacts of the introduction of a triage system in Japan: a time series study." 1(3): 153-8. Takaoka, K., et al. (2021). "Utility of the Emergency Severity Index by Accuracy of Interrater Agreement by Expert Triage Nurses in a Simulated Scenario in Japan: A Randomized Controlled Trial." Journal of Emergency Nursing 47(4): 669-674.
Korean Triage and Acuity Scale (KTAS)	J. H, H., et al. (2019). "A Study of the Korea Triage and Acuity Scale Using National Emergency Department Information System Analysis...10th Mediterranean Emergency Medicine Congress, 22-25 September, 2019, Dubrovnik, Croatia." Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health 20: S11-S11. Moon, S. H., et al. (2019). "Triage accuracy and causes of mistriage using the Korean Triage and Acuity Scale." PLoS ONE [Electronic Resource] 14(9): e0216972. Ryu, J. H., et al. (2019). "Changes in Relative Importance of the 5-Level Triage System, Korean Triage and Acuity Scale, for the Disposition of Emergency Patients Induced by Forced Reduction in Its Level Number: a Multi-Center Registry-based Retrospective Cohort Study." Journal of Korean Medical Science 34(14): e114. Yu, J. Y., et al. (2022). "An external validation study of the Score for Emergency Risk Prediction (SERP), an interpretable machine learning-based triage score for the emergency department." Scientific Reports 12(1): 17466.
Machine-learning risk prediction models (AI models)	Chang, Y.-H., et al. (2022). "Machine learning-based triage to identify low-severity patients with a short discharge length of stay in emergency department." BMC Emergency Medicine 22(1): 1-10. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Kareemi, H., et al. (2021). "Machine Learning Versus Usual Care for Diagnostic and Prognostic Prediction in the Emergency Department: A Systematic Review." Academic Emergency Medicine 28(2): 184-196. Kwon, J. M., et al. (2018). "Validation of deep-learning-based triage and acuity

Tool	Citations
	score using a large national dataset." PLoS ONE [Electronic Resource] 13(10): e0205836. Lee, J. T., et al. (2021). "Prediction of hospitalization using artificial intelligence for urgent patients in the emergency department." Scientific Reports 11(1): 19472. Levin, S., et al. (2018). "Machine-Learning-Based Electronic Triage More Accurately Differentiates Patients With Respect to Clinical Outcomes Compared With the Emergency Severity Index." Annals of Emergency Medicine 71(5): 565-574.e2. Naemi, A., et al. (2020). "Personalized Predictive Models for Identifying Clinical Deterioration Using LSTM in Emergency Departments." Studies in Health Technology & Informatics 275: 152-156. Nguyen, M., et al. (2021). "Developing machine learning models to personalize care levels among emergency room patients for hospital admission." Journal of the American Medical Informatics Association 28(11): 2423-2432. Raita, Y., et al. (2019). "Emergency department triage prediction of clinical outcomes using machine learning models." Critical Care (London, England) 23(1): 64. Rendell, K., et al. (2019). "The Sydney Triage to Admission Risk Tool (START2) using machine learning techniques to support disposition decision-making." Emergency Medicine Australasia 31(3): 429-435. Sanchez-Salmeron, R., et al. (2022). "Machine learning methods applied to triage in emergency services: A systematic review." International emergency nursing 60: 101109. van Doorn, W. P. T. M., et al. (2021). "Explainable Machine Learning models for Rapid Risk Stratification in the Emergency Department: A multi-center study." medRxiv: 2020.11.25.20238386. Wang, S. T. (2013). "Construct an optimal triage prediction model: a case study of the emergency department of a teaching hospital in Taiwan." 1(5): 9968. Wunsch, G., et al. (2017). "A Semantic-Based Model for Triage Patients in Emergency Departments." 1(4): 65. Yao, L. H., et al. (2021). "A Novel Deep Learning-Based System for Triage in the Emergency Department Using Electronic Medical Records: Retrospective Cohort Study." Journal of Medical Internet Research 23(12): e27008. Yu, J. Y., et al. (2022). "An external validation study of the Score for Emergency Risk Prediction (SERP), an interpretable machine learning-based triage score for the emergency department." Scientific Reports 12(1): 17466. Zlotnik, A., et al. (2016). "Building a Decision Support System for Inpatient Admission Prediction With the Manchester Triage System and Administrative Check-in Variables." CIN: Computers, Informatics, Nursing 34(5): 224-230. Zmiri, D., et al. (2012). "Classification of patients by severity grades during triage in the emergency department using data mining methods." Journal of Evaluation in Clinical Practice 18(2): 378-388.
Manchester Triage System (MTS)	Akira Kuriyama, S. U. T. N. (2017). "Five-level emergency triage systems: variation in assessment of validity." Emergency Medicine Journal: 703-710. Azeredo, T. R., et al. (2015). "Efficacy of the Manchester Triage System: a systematic review." International emergency nursing 23(2): 47-52. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric

Tool	Citations
	emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Gaumont, D., et al. (2016). "ViEWS from the prehospital perspective: a comparison with a prehospital score to triage categorisation in the emergency department." 1(6): 423. Joany M Zachariasse, et al. (2019). "Performance of triage systems in emergency care: a systematic review and meta-analysis." BMJ open: e026471. Joany M Zachariasse, N et al. (2017). "Validity of the Manchester Triage System in emergency care: A prospective observational study." PLoS ONE: e0170811. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227. McCabe, C., et al. (2019). "The introduction of the Early Warning Score in the Emergency Department: A retrospective cohort study." International emergency nursing 45: 31-35. Mirhaghi, A., et al. (2017). "The reliability of the Manchester Triage System (MTS): a meta-analysis." 1(2): 129-135. Möckel, M., et al. (2020). "["Triage"-primary assessment of patients in the emergency department : An overview with a systematic review]." Medizinische Klinik, Intensivmedizin und Notfallmedizin 115(8): 668-681. Mota Guedes, H., et al. (2017). "Outcome assessment of patients classified through the Manchester Triage System in emergency units in Brazil and Portugal." Investigacion & Educacion en Enfermeria 35(2): 174-181. Nicola Parenti, M. L. B. R. P. I. D. P. D. D. (2014). "A systematic review on the validity and reliability of an emergency department triage scale, the Manchester Triage System." International journal of nursing studies: 1062-9. Santos, A. P., et al. (2014). "Manchester triage system version II and resource utilisation in the emergency department." Emergency Medicine Journal 31(2): 148-152. Souza, C. C., et al. (2015). "[Scientific Literature on the Reliability and Validity of the Manchester Triage System (MTS) Protocol: A Integrative Literature Review]." Revista da Escola de Enfermagem da U S P 49(1): 144-51. Steiner, D., et al. (2016). "Performance of the Manchester Triage System in Adult Medical Emergency Patients: A Prospective Cohort Study." 1(4): 678-89. van der Straten, L. M., et al. (2012). "Safety and efficiency of triaging low urgent self-referred patients to a general practitioner at an acute care post: an observational study." 1(11): 877-81. Vredebregt, S. J., et al. (2019). "Recognizing critically ill children with a modified pediatric early warning score at the emergency department, a feasibility study." European Journal of Pediatrics 178(2): 229-234. Zlotnik, A., et al. (2016). "Building a Decision Support System for Inpatient Admission Prediction With the Manchester Triage System and Administrative Check-in Variables." CIN: Computers, Informatics, Nursing 34(5): 224-230.

Tool	Citations
Medical Priority Dispatch System (MPDS)	Andrew, E., et al. (2019). "Aligning ambulance dispatch priority to patient acuity: A methodology." Emergency Medicine Australasia 31(3): 405-410.
Modified Early Warning Score (MEWS)	Bulut, M., et al. (2014). "The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department." Emergency Medicine Journal 31(6): 476-481. Bulut, M., et al. (2014). "The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department." Emergency Medicine Journal 31(6): 476-481. Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696. Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696.
Modified Japanese Triage and Acuity Scale (mJTAS)	Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696.
Modified Pediatric Early Warning Score (mPEWS)	Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696.
Modified Rapid Emergency Medicine Score (mREMS)	Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696.
National Early Warning Score (NEWS)	Alam, N., et al. (2015). "Exploring the performance of the National Early Warning Score (NEWS) in a European emergency department." 1: 111-5. Alam, N., et al. (2015). "Exploring the performance of the National Early Warning Score (NEWS) in a European emergency department." 1: 111-5.
National Early Warning Score 2 (NEWS2)	Martin-Rodriguez, F., et al. (2019). "Analysis of the early warning score to detect critical or high-risk patients in the prehospital setting." Internal & Emergency Medicine 14(4): 581-589. Martin-Rodriguez, F., et al. (2019). "Analysis of the early warning score to detect critical or high-risk patients in the prehospital setting." Internal & Emergency Medicine 14(4): 581-589. Martin-Rodriguez, F., et al. (2019). "Analysis of the early warning score to detect critical or high-risk patients in the prehospital setting." Internal & Emergency Medicine 14(4): 581-589. Vergara, P., et al. (2021). "Validation of the National Early Warning Score (NEWS)-2 for adults in the emergency department in a tertiary-level clinic in Colombia: Cohort study." Medicine 100(40): e27325-e27325.
Netherlands Triage System (NTS)	Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696. Smits, M., et al. (2022). "Reliability and validity of the Netherlands Triage Standard in emergency care settings: a case scenario study." Emergency Medicine Journal

Tool	Citations
	39(8): 623-627.
Paediatric Observation Priority Score (POPS)	Langton, L., et al. (2018). "Inter-rater reliability in the Paediatric Observation Priority Score (POPS)." Archives of Disease in Childhood 103(5): 458-462. Roland, D., et al. (2017). "Baseline Characteristics of the Paediatric Observation Priority Score in Emergency Departments outside Its Centre of Derivation." 1: 9060852.
Paediatric Taiwan Triage and Acuity System (Ped-TTAS)	Chang, Y.-C., et al. (2013). "Effectiveness of a five-level Paediatric Triage System: an analysis of resource utilisation in the emergency department in Taiwan." Emergency Medicine Journal 30(9): 735-739. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Paediatric Taiwan Triage System (Ped-TTS)	Chang, Y.-C., et al. (2013). "Effectiveness of a five-level Paediatric Triage System: an analysis of resource utilisation in the emergency department in Taiwan." Emergency Medicine Journal 30(9): 735-739.
Paper-based triage system (Paper-based)	Agnihotri, T., et al. (2021). "Impact of an Electronic Decision-Support System on Nursing Triage Process: A Usability and Workflow Analysis." Canadian Journal of Nursing Research 53(2): 107-113.
Paramedic Pathfinder (PP)	Chang, Y.-C., et al. (2013). "Effectiveness of a five-level Paediatric Triage System: an analysis of resource utilisation in the emergency department in Taiwan." Emergency Medicine Journal 30(9): 735-739.
Pediatric Assessment Triangle (PAT)	Chang, Y.-C., et al. (2013). "Effectiveness of a five-level Paediatric Triage System: an analysis of resource utilisation in the emergency department in Taiwan." Emergency Medicine Journal 30(9): 735-739. Horeczko, T., et al. (2013). "The Pediatric Assessment Triangle: Accuracy of Its Application by Nurses in the Triage of Children." Journal of Emergency Nursing 39(2): 182-189.
Pediatric Canadian Triage and Acuity Scale (PedCTAS)	Allon, R., et al. (2018). "Validity of the Pediatric Canadian Triage Acuity Scale in a tertiary children's hospital in Israel." European Journal of Emergency Medicine 25(4): 270-273. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227.
Pediatric Early Warning Score (PEWS)	Breslin, K., et al. (2014). "Pediatric early warning score at time of emergency department disposition is associated with level of care." 1(2): 97-103. Lillitos, P. J., et al. (2016). "Can paediatric early warning scores (PEWS) be used to guide the need for hospital admission and predict significant illness in children presenting to the emergency department? An assessment of PEWS diagnostic accuracy using sensitivity and specificity." Emergency Medicine Journal 33(5): 329-337.

Tool	Citations
	McElroy, T., et al. (2019). "Implementation study of a 5-component pediatric early warning system (PEWS) in an emergency department in British Columbia, Canada, to inform provincial scale up." BMC Emergency Medicine 19(1): 74. Niu, X., et al. (2016). "Feasibility and Reliability of Pediatric Early Warning Score in the Emergency Department." 1(2): 161-6. Zachariasse, J. M., et al. (2020). "Development and validation of a Paediatric Early Warning Score for use in the emergency department: a multicentre study." The Lancet Child & Adolescent Health 4(8): 583-591.
Pediatric Sequential Organ Failure Assessment (pSOFA) score	Balamuth, F., et al. (2022). "Validation of the Pediatric Sequential Organ Failure Assessment Score and Evaluation of Third International Consensus Definitions for Sepsis and Septic Shock Definitions in the Pediatric Emergency Department." JAMA Pediatrics 176(7): 672-678.
Prehospital National Early Warning Score (Ph-ViEWS)	Gaumont, D., et al. (2016). "ViEWS from the prehospital perspective: a comparison with a prehospital score to triage categorisation in the emergency department." 1(6): 423.
Prehospital National Early Warning Score 2 Lactate (PreNEWS2-L)	Martin-Rodriguez, F., et al. (2019). "Predictive value of the prehospital NEWS2-L - National Early Warning Score 2 Lactate- for detecting early death after an emergency." Emergencias 31(3): 173-179.
Princess Marina Triage Scale (PMTS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Quick Sequential Organ Failure Assessment (qSOFA) score	Kwak, H., et al. (2018). "Prognostic performance of Emergency Severity Index (ESI) combined with qSOFA score." American Journal of Emergency Medicine 36(10): 1784-1788.
Quick-look triage approach (QLT)	Iversen, A. K. S., et al. (2019). "A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department." Emergency Medicine Journal 36(2): 66-71.
Ramathibodi Triage System (RTS)	Betz, M., et al. (2016). "A comparison of a formal triage scoring system and a quick-look triage approach." 1(3): 185-9. Iversen, A. K. S., et al. (2019). "A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department." Emergency Medicine Journal 36(2): 66-71.
Rapid Emergency Medicine Score (REMS)	Alter, S. M., et al. (2017). "Evaluating clinical care in the prehospital setting: Is Rapid Emergency Medicine Score the missing metric of EMS?" 1(2): 218-221. Bulut, M., et al. (2014). "The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department." Emergency Medicine Journal 31(6): 476-481
Rapid Emergency Triage and Treatment System (RETTS)	Habbouche, S., et al. (2022). "Comparison of the novel WEst coast System for Triage (WEST) with Rapid Emergency Triage and Treatment System (RETTS©): an observational pilot study." International Journal of Emergency Medicine 15(1): 1-10. Habbouche, S., et al. (2022). "Comparison of the novel WEst coast System for Triage (WEST) with Rapid Emergency Triage and Treatment System (RETTS©): an observational pilot study." International Journal of Emergency Medicine 15(1): 1-10.
Rapid Emergency Triage and Treatment System - Hospital	Perez, N., et al. (2016). "The predictive validity of RETTS-HEV as an acuity triage tool in the emergency department of a Danish Regional Hospital." 1(1): 33-7.

Tool	Citations
Unit West (RETTS-HEV)	
Rapid team triage (Rapid team)	Hosking, J., et al. (2014). "Recognising clinical deterioration in emergency department patients." 1(2): 59-67.
RISKINDEX	van Doorn, W. P. T. M., et al. (2021). "Explainable Machine Learning models for Rapid Risk Stratification in the Emergency Department: A multi-center study." medRxiv: 2020.11.25.20238386.
Score for Emergency Risk Prediction (SERP)	van Doorn, W. P. T. M., et al. (2021). "Explainable Machine Learning models for Rapid Risk Stratification in the Emergency Department: A multi-center study." medRxiv: 2020.11.25.20238386.
Secondary telephone triage (Phone)	Eastwood, K., et al. (2015). "Secondary triage in prehospital emergency ambulance services: a systematic review." Emergency Medicine Journal 32(6): 486-92.
Simple Prognostic Score (SPS)	Eastwood, K., et al. (2015). "Secondary triage in prehospital emergency ambulance services: a systematic review." Emergency Medicine Journal 32(6): 486-92.
Simple Triage and Rapid Treatment (START)	Hart, A., et al. (2018). "Intuitive versus Algorithmic Triage." Prehospital & Disaster Medicine 33(4): 355-361. Hong, R., et al. (2015). "Comparison of START triage categories to emergency department triage levels to determine need for urgent care and to predict hospitalization." 1(1): 13-21.
Soterion Rapid Triage System (SRTS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
South African Triage Scale (SATS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Streaming	Olaussen, A., et al. (2021). "Paramedic streaming upon arrival in emergency department: A prospective study." Emergency Medicine Australasia 33(2): 286-291. Olaussen, A., et al. (2021). "Paramedic streaming upon arrival in emergency department: A prospective study." Emergency Medicine Australasia 33(2): 286-291.
Sydney Triage to Admission Risk Tool (START)	Ebker-White, A. A., et al. (2018). "The Sydney Triage to Admission Risk Tool (START): A prospective validation study." Emergency Medicine Australasia 30(4): 511-516. Rendell, K., et al. (2019). "The Sydney Triage to Admission Risk Tool (START2) using machine learning techniques to support disposition decision-making." Emergency Medicine Australasia 31(3): 429-435.
Taiwan Triage and Acuity Scale (TTAS)	Chip-Jin Ng, et al. (2019). "Validation of the five-tier Taiwan Triage and Acuity Scale for prehospital use by Emergency Medical Technicians." Emergency Medicine Journal: 472-478.
Three-level triage scale (TLTS, modified ATS)	Lam, R. P. K., et al. (2020). "Performance of a three-level triage scale in live triage encounters in an emergency department in Hong Kong." International Journal of Emergency Medicine 13(1): 1-8.
Triage Risk Stratification Tool (TRST)	Cousins, G., et al. (2013). "Adverse outcomes in older adults attending emergency department: systematic review and meta-analysis of the Triage Risk Stratification Tool. [Review]." 1(4): 230-9. Salvi, F., et al. (2016). Predictive validity of different versions of the Triage Risk Screening Tool. Philadelphia, Pennsylvania, Elsevier B.V. 34: 2454-2456.

Tool	Citations
Vitalpac Early Warning Score (VEWS)	Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606.
WEst coast System for Triage (WEST)	Habbouche, S., et al. (2022). "Comparison of the novel WEst coast System for Triage (WEST) with Rapid Emergency Triage and Treatment System (RETTS©): an observational pilot study." International Journal of Emergency Medicine 15(1): 1-10.

Appendix 6: Citations of studies reporting on outcome measures used to assess effectiveness of acuity assessment tools

Tool	Citations
Algorithmic	Villa, S., et al. (2018). "Decreasing triage time: effects of implementing a step-wise ESI algorithm in an EHR." International Journal for Quality in Health Care 30(5): 375-381.
Australasian Triage Scale (ATS)	Alpert, E. A., et al. (2013). "Simulated evaluation of two triage scales in an emergency department in Israel." 1(6): 431-4. Burgess, L., et al. (2019). "Implementing best practice into the emergency department triage process." International Journal of Evidence-Based Healthcare 17(1): 27-35 Cheng, D. R., et al. (2016). "Effect of a pager notification system on Australasian Triage Scale category 2 patients in a paediatric emergency department." 1(4): 434-8. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227.
Canadian Triage and Acuity Scale (CTAS)	Daren Lin, A. W. (2013). "Predictors of admission to hospital of patients triaged as nonurgent using the Canadian Triage and Acuity Scale." CJEM: 353-8. Preyde, M., et al. (2012). "Patients' satisfaction and wait times at Guelph General Hospital Emergency Department before and after implementation of a process improvement project." 1(3): 157-68. Smith, D. T., et al. (2015). "Analyzing the Usability of the 5-Level Canadian Triage and Acuity Scale By Paramedics in the Prehospital Environment." 1(6): 489-95. Trivedi, S., et al. (2021). "A Comparison Between Computer-Assisted Self-Triage by Patients and Triage Performed by Nurses in the Emergency Department." Cureus 13(3): e14002.
Clinical Decision Support System (CDSS)	Bennett, P. and Hardiker, N. (2016). "A Quantitative Study Investigating the Effects of Computerised Clinical Decision Support in the Emergency Department." 1: 53-7. Feral-Pierssens, A.-L., et al. (2022). "Safety assessment of a redirection program using an electronic application for low-acuity patients visiting an emergency department." BMC Emergency Medicine 22(1): 1-9.
Danish Emergency Process Triage (DEPT)	Iversen, A. K. S., et al. (2019). "A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department." Emergency Medicine Journal 36(2): 66-71.
Dynamic Grouping and Prioritization (DGP) algorithm	Ashour, O., et al. (2016). "Dynamic patient grouping and prioritization: a new approach to emergency department flow improvement." Health Care Management Science 19(2): 192-205.
Electronic Canadian Triage and Acuity Scale (eCTAS)	Agnihotri, T., et al. (2021). "Impact of an Electronic Decision-Support System on Nursing Triage Process: A Usability and Workflow Analysis." Canadian Journal of

Tool	Citations
	Nursing Research 53(2): 107-113.
Electronic patient self-triage	Trivedi, S., et al. (2021). "A Comparison Between Computer-Assisted Self-Triage by Patients and Triage Performed by Nurses in the Emergency Department." Cureus 13(3): e14002.
Emergency Department Triage Early Warning Score (TREWS)	Lee, S. B., et al. (2020). "Emergency Department Triage Early Warning Score (TREWS) predicts in-hospital mortality in the emergency department." American Journal of Emergency Medicine 38(2): 203-210. Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606.
Emergency Severity Index (ESI)	Alpert, E. A., et al. (2013). "Simulated evaluation of two triage scales in an emergency department in Israel." 1(6): 431-4. Ashour, O., et al. (2016). "Dynamic patient grouping and prioritization: a new approach to emergency department flow improvement." Health Care Management Science 19(2): 192-205. Brosinski, C. M., et al. (2017). "Improving Triage Accuracy: A Staff Development Approach." 1(3): 145-148. Busch, J.-M., et al. (2022). "Validation of a Simple Score for Mortality Prediction in a Cohort of Unselected Emergency Patients." International Journal of Clinical Practice: 1-9. Darnton, P., et al. (2018). "Independent evaluation of the North East Hampshire and Farnham Vanguard: emergency severity index." de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Green, N. A., et al. (2012). "Emergency Severity Index version 4: a valid and reliable tool in pediatric emergency department triage." 1(8): 753-7. Hong, R., et al. (2015). "Comparison of START triage categories to emergency department triage levels to determine need for urgent care and to predict hospitalization." 1(1): 13-21. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227. Kwak, H., et al. (2018). "Prognostic performance of Emergency Severity Index (ESI) combined with qSOFA score." American Journal of Emergency Medicine 36(10): 1784-1788. Levin, S., et al. (2018). "Machine-Learning-Based Electronic Triage More Accurately Differentiates Patients With Respect to Clinical Outcomes Compared With the

Tool	Citations
	Emergency Severity Index." Annals of Emergency Medicine 71(5): 565-574.e2. McHugh, M., et al. (2012). "More patients are triaged using the Emergency Severity Index than any other triage acuity system in the United States." 1(1): 106-9. Raita, Y., et al. (2019). "Emergency department triage prediction of clinical outcomes using machine learning models." Critical Care (London, England) 23(1): 64. Singer, R. F., et al. (2012). "The use of and satisfaction with the Emergency Severity Index." 1(2): 120-6. Smith, D. T., et al. (2015). "Analyzing the Usability of the 5-Level Canadian Triage and Acuity Scale By Paramedics in the Prehospital Environment." 1(6): 489-95. Theiling, B. J., et al. (2020). "A Method for Grouping Emergency Department Visits by Severity and Complexity." The Western Journal of Emergency Medicine 21(5): 1147-1155. Vergara, P., et al. (2021). "Validation of the National Early Warning Score (NEWS)-2 for adults in the emergency department in a tertiary-level clinic in Colombia: Cohort study." Medicine 100(40): e27325-e27325. Villa, S., et al. (2018). "Decreasing triage time: effects of implementing a step-wise ESI algorithm in an EHR." International Journal for Quality in Health Care 30(5): 375-381. Volk, S., et al. (2022). "Patient disposition using the Emergency Severity Index: a retrospective observational study at an interdisciplinary emergency department." BMJ Open 12(5): e057684. Whitfield, C. G. (2013). Emergency department triage acuity ratings: Embedding ESI into the electronic medical record. University of South Carolina. 208 p-208 p. Wolf, L. A. and Delao, A. M. (2021). "Establishing Research Priorities for the Emergency Severity Index Using a Modified Delphi Approach." Journal of Emergency Nursing 47(1): 50-57. Worth, M. G. (2017). "Structure, Process, and Recommendations of Emergency Department Triage in the U.S." Structure, Process & Recommendations of Emergency Department Triage in the U.S: 1-1.
Expert practitioner	Baimas-George, M., et al. (2022). "Emergency general surgery transfer to lower acuity facility: The role of right-sizing care in emergency general surgery regionalization." The Journal of Trauma and Acute Care Surgery 92(1): 38-43. Hart, A., et al. (2018). "Intuitive versus Algorithmic Triage." Prehospital & Disaster Medicine 33(4): 355-361 Wiswell, J., et al. (2013). "'Sick' or 'not-sick': accuracy of System 1 diagnostic reasoning for the prediction of disposition and acuity in patients presenting to an academic ED." American Journal of Emergency Medicine 31(10): 1448-1452.
Hillerod Acute Process Triage (HAPT) system	Barfod, C., et al. (2012). "Abnormal vital signs are strong predictors for intensive care unit admission and in-hospital mortality in adults triaged in the emergency department - a prospective cohort study." 1: 28.

Tool	Citations
Illness Rating Score (IRS)	O'Neill, L. B., et al. (2021). ""Sick or not sick?" A mixed methods study evaluating the rapid determination of illness severity in a pediatric emergency department." Diagnosis 9(2): 207-215.
Japanese Triage and Acuity Scale (JTAS)	Akira Kuriyama, T. I. T. K. T. F. T. N. (2018). "Validity of the Japan Acuity and Triage Scale in adults: a cohort study." Emergency Medicine Journal: 384-388. Hamamoto, J., et al. (2014). "Impacts of the introduction of a triage system in Japan: a time series study." 1(3): 153-8. Toru Koyama, et al. (2017). "A study of the effect of introduction of JTAS in the emergency room." Acute medicine & surgery: 262-270.
Korean Triage and Acuity Scale (KTAS)	Hyuksool Kwon, Y. et al. (2019). "The Korean Triage and Acuity Scale: associations with admission, disposition, mortality and length of stay in the emergency department." International Journal for Quality in Health Care: 449-455. J. H, H., et al. (2019). "A Study of the Korea Triage and Acuity Scale Using National Emergency Department Information System Analysis...10th Mediterranean Emergency Medicine Congress, 22-25 September, 2019, Dubrovnik, Croatia." Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health 20: S11-S11. Yu, J. Y., et al. (2022). "An external validation study of the Score for Emergency Risk Prediction (SERP), an interpretable machine learning-based triage score for the emergency department." Scientific Reports 12(1): 17466.
Machine-learning risk prediction models (AI models)	Anonymous (2020). "Using machine-learning risk prediction models to triage the acuity of undifferentiated patients entering the emergency care system: a systematic review." Diagnostic and prognostic research. Chang, Y.-H., et al. (2022). "Machine learning-based triage to identify low-severity patients with a short discharge length of stay in emergency department." BMC Emergency Medicine 22(1): 1-10. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Lee, J. T., et al. (2021). "Prediction of hospitalization using artificial intelligence for urgent patients in the emergency department." Scientific Reports 11(1): 19472. Levin, S., et al. (2018). "Machine-Learning-Based Electronic Triage More Accurately Differentiates Patients With Respect to Clinical Outcomes Compared With the Emergency Severity Index." Annals of Emergency Medicine 71(5): 565-574.e2. Nguyen, M., et al. (2021). "Developing machine learning models to personalize care levels among emergency room patients for hospital admission." Journal of the American Medical Informatics Association 28(11): 2423-2432. Raita, Y., et al. (2019). "Emergency department triage prediction of clinical outcomes using machine learning models." Critical Care (London, England) 23(1): 64. van Doorn, W. P. T. M., et al. (2021). "Explainable Machine Learning models for Rapid Risk Stratification in the Emergency Department: A multi-center study."

Tool	Citations
	medRxiv: 2020.11.25.20238386. Wunsch, G., et al. (2017). "A Semantic-Based Model for Triage Patients in Emergency Departments." 1(4): 65. Yu, J. Y., et al. (2022). "An external validation study of the Score for Emergency Risk Prediction (SERP), an interpretable machine learning-based triage score for the emergency department." Scientific Reports 12(1): 17466.
Manchester Triage System (MTS)	Azeredo, T. R., et al. (2015). "Efficacy of the Manchester Triage System: a systematic review." International emergency nursing 23(2): 47-52. Beck, N., et al. (2022). "The Manchester Triage System in a Pediatric Emergency Department of an Austrian University Hospital: A Retrospective Analysis of Urgency Levels." Pediatric Emergency Care 38(2): e639-e643. Cicolo, E. A., et al. (2020). "Effectiveness of the Manchester Triage System on time to treatment in the emergency department: a systematic review." JBI Evidence Synthesis 18(1): 56-73. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Fernandes, M., et al. (2020). "Predicting Intensive Care Unit admission among patients presenting to the emergency department using machine learning and natural language processing." PLoS ONE [Electronic Resource] 15(3): e0229331. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227. McCabe, C., et al. (2019). "The introduction of the Early Warning Score in the Emergency Department: A retrospective cohort study." International emergency nursing 45: 31-35. Mota Guedes, H., et al. (2017). "Outcome assessment of patients classified through the Manchester Triage System in emergency units in Brazil and Portugal." Investigacion & Educacion en Enfermeria 35(2): 174-181. Nicola Parenti, M. L. B. R. P. I. D. P. D. D. (2014). "A systematic review on the validity and reliability of an emergency department triage scale, the Manchester Triage System." International journal of nursing studies: 1062-9. Santos, A. P., et al. (2014). "Manchester triage system version II and resource utilisation in the emergency department." Emergency Medicine Journal 31(2): 148-152. Souza, C. C., et al. (2015). "[Scientific Literature on the Reliability and Validity of the Manchester Triage System (MTS) Protocol: A Integrative Literature Review]." Revista da Escola de Enfermagem da U S P 49(1): 144-51. van der Straten, L. M., et al. (2012). "Safety and efficiency of triaging low urgent self-referred patients to a general practitioner at an acute care post: an observational study." 1(11): 877-81.

Tool	Citations
	Vredebregt, S. J., et al. (2019). "Recognizing critically ill children with a modified pediatric early warning score at the emergency department, a feasibility study." European Journal of Pediatrics 178(2): 229-234.
Modified Early Warning Score (MEWS)	Bulut, M., et al. (2014). "The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department." Emergency Medicine Journal 31(6): 476-481. Griffiths, J. R., et al. (2012). "Current use of early warning scores in UK emergency departments." Emergency Medicine Journal 29(1): 65-66. J. H, H., et al. (2019). "A Study of the Korea Triage and Acuity Scale Using National Emergency Department Information System Analysis...10th Mediterranean Emergency Medicine Congress, 22-25 September, 2019, Dubrovnik, Croatia." Western Journal of Emergency Medicine: Integrating Emergency Care with Population Health 20: S11-S11. Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696.
Modified Japanese Triage and Acuity Scale (mJTAS)	Hiraku, F., et al. (2016). "Validation of the modified Japanese Triage and Acuity Scale-based triage system emphasizing the physiologic variables or mechanism of injuries." International Journal of Emergency Medicine 9: 1-6.
Modified Pediatric Early Warning Score (mPEWS)	Vredebregt, S. J., et al. (2019). "Recognizing critically ill children with a modified pediatric early warning score at the emergency department, a feasibility study." European Journal of Pediatrics 178(2): 229-234.
Modified Rapid Emergency Medicine Score (mREMS)	Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606.
National Early Warning Score (NEWS)	Kivipuro, M., et al. (2018). "National early warning score (NEWS) in a Finnish multidisciplinary emergency department and direct vs. late admission to intensive care." Resuscitation 128: 164-169.
National Early Warning Score 2 (NEWS2)	Martin-Rodriguez, F., et al. (2019). "Analysis of the early warning score to detect critical or high-risk patients in the prehospital setting." Internal & Emergency Medicine 14(4): 581-589. Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606. Masson, H. and Stephenson, J. (2022). "Investigation into the predictive capability for mortality and the trigger points of the National Early Warning Score 2 (NEWS2) in emergency department patients." Emergency Medicine Journal 39(9): 685-690. Vergara, P., et al. (2021). "Validation of the National Early Warning Score (NEWS)-2 for adults in the emergency department in a tertiary-level clinic in Colombia: Cohort study." Medicine 100(40): e27325-e27325.
Netherlands Triage System	Schinkel, M., et al. (2022). "Comparing complaint-based triage scales and early

Tool	Citations
(NTS)	warning scores for emergency department triage." Emergency Medicine Journal 39(9): 691-696.
Paediatric Taiwan Triage and Acuity System (Ped-TTAS)	Chang, Y.-C., et al. (2013). "Effectiveness of a five-level Paediatric Triage System: an analysis of resource utilisation in the emergency department in Taiwan." Emergency Medicine Journal 30(9): 735-739. de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Paediatric Taiwan Triage System (Ped-TTS)	Chang, Y.-C., et al. (2013). "Effectiveness of a five-level Paediatric Triage System: an analysis of resource utilisation in the emergency department in Taiwan." Emergency Medicine Journal 30(9): 735-739.
Paper-based triage system (Paper-based)	Agnihotri, T., et al. (2021). "Impact of an Electronic Decision-Support System on Nursing Triage Process: A Usability and Workflow Analysis." Canadian Journal of Nursing Research 53(2): 107-113.
Paramedic Pathfinder (PP)	Newton, M., et al. (2014). "Clinical navigation for beginners: the clinical utility and safety of the Paramedic Pathfinder." 1(e1): e29-34.
Pediatric Canadian Triage and Acuity Scale (PedCTAS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719. Holt, T., et al. (2018). "The Canadian Paediatric Triage and Acuity Scale algorithm for interfacility transport." American Journal of Disaster Medicine 13(1): 57-63. Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227.
Pediatric Early Warning Score (PEWS)	Lillitos, P. J., et al. (2016). "Can paediatric early warning scores (PEWS) be used to guide the need for hospital admission and predict significant illness in children presenting to the emergency department? An assessment of PEWS diagnostic accuracy using sensitivity and specificity." Emergency Medicine Journal 33(5): 329-337. McElroy, T., et al. (2019). "Implementation study of a 5-component pediatric early warning system (PEWS) in an emergency department in British Columbia, Canada, to inform provincial scale up." BMC Emergency Medicine 19(1): 74.
Pediatric Sequential Organ Failure Assessment (pSOFA) score	Balamuth, F., et al. (2022). "Validation of the Pediatric Sequential Organ Failure Assessment Score and Evaluation of Third International Consensus Definitions for Sepsis and Septic Shock Definitions in the Pediatric Emergency Department." JAMA Pediatrics 176(7): 672-678.
Pivot triage process (Pivot)	Christensen, M., et al. (2016). "Pivot Nursing: An Alternative to Traditional ED Triage." Journal of Emergency Nursing 42(5): 395-399.
Prehospital National Early Warning Score 2 Lactate (PreNEWS2-L)	Martin-Rodriguez, F., et al. (2019). "Predictive value of the prehospital NEWS2-L - National Early Warning Score 2 Lactate- for detecting early death after an emergency." Emergencias 31(3): 173-179.

Tool	Citations
Princess Marina Triage Scale (PMTS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Quick Sequential Organ Failure Assessment (qSOFA) score	Kwak, H., et al. (2018). "Prognostic performance of Emergency Severity Index (ESI) combined with qSOFA score." American Journal of Emergency Medicine 36(10): 1784-1788.
Quick-look triage approach (QLT)	Ahc, M. (2018). "A Deeper Exploration of How ED Nurses Triage." ED Legal Letter 29(12): 0-0. Iversen, A. K. S., et al. (2019). "A simple clinical assessment is superior to systematic triage in prediction of mortality in the emergency department." Emergency Medicine Journal 36(2): 66-71.
Ramathibodi Triage System (RTS)	Kanokwan Aeimchanbanjong, U. P. (2017). "Validation of different pediatric triage systems in the emergency department." World journal of emergency medicine: 223-227.
Rapid Emergency Medicine Score (REMS)	Bulut, M., et al. (2014). "The comparison of modified early warning score with rapid emergency medicine score: a prospective multicentre observational cohort study on medical and surgical patients presenting to emergency department." Emergency Medicine Journal 31(6): 476-481.
Rapid Emergency Triage and Treatment System (RETTS)	Habbouche, S., et al. (2022). "Comparison of the novel WEst coast System for Triage (WEST) with Rapid Emergency Triage and Treatment System (RETTS©): an observational pilot study." International Journal of Emergency Medicine 15(1): 1-10. Wireklint, S. C., et al. (2021). "An updated national survey of triage and triage related work in Sweden: a cross-sectional descriptive and comparative study." Scandinavian Journal of Trauma, Resuscitation & Emergency Medicine 29(1): 89.
Rapid Emergency Triage and Treatment System - Hospital Unit West (RETTS-HEV)	Perez, N., et al. (2016). "The predictive validity of RETTS-HEV as an acuity triage tool in the emergency department of a Danish Regional Hospital." 1(1): 33-7.
Rapid Emergency Triage and Treatment System-paediatrics (RETTS-p)	Magnusson, C., et al. (2018). "Initial assessment, level of care and outcome among children who were seen by emergency medical services: a prospective observational study." Scandinavian Journal of Trauma, Resuscitation & Emergency Medicine 26(1): 88.
Rapid team triage (Rapid team)	Shea, S. S. and Hoyt, K. S. (2012). ""RAPID" team triage: one hospital's approach to patient-centered team triage." 1(2): 177-89.
RISKINDEX	van Doorn, W. P. T. M., et al. (2021). "Explainable Machine Learning models for Rapid Risk Stratification in the Emergency Department: A multi-center study." medRxiv: 2020.11.25.20238386.
Score for Emergency Risk Prediction (SERP)	Yu, J. Y., et al. (2022). "An external validation study of the Score for Emergency Risk Prediction (SERP), an interpretable machine learning-based triage score for the emergency department." Scientific Reports 12(1): 17466.
Secondary telephone triage (Phone)	Eastwood, K., et al. (2015). "Secondary triage in prehospital emergency ambulance services: a systematic review." Emergency Medicine Journal 32(6): 486-92.

Tool	Citations
Senior Streaming Assessment Further Evaluation after Triage (SAFE-T) Zone	Amith Shetty, N. G. K. B. M. V. (2012). "Senior Streaming Assessment Further Evaluation after Triage zone: A novel model of care encompassing various emergency department throughput measures." Emergency medicine Australasia: 374-82.
Simple Prognostic Score (SPS)	Busch, J.-M., et al. (2022). "Validation of a Simple Score for Mortality Prediction in a Cohort of Unselected Emergency Patients." International Journal of Clinical Practice: 1-9.
Simple Triage and Rapid Treatment (START)	Hart, A., et al. (2018). "Intuitive versus Algorithmic Triage." Prehospital & Disaster Medicine 33(4): 355-361. Hong, R., et al. (2015). "Comparison of START triage categories to emergency department triage levels to determine need for urgent care and to predict hospitalization." 1(1): 13-21.
Soterion Rapid Triage System (SRTS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
South African Triage Scale (SATS)	de Magalhães-Barbosa, M. C., et al. (2017). "Validity of triage systems for paediatric emergency care: a systematic review." Emergency medicine journal : EMJ 34(11): 711-719.
Streaming	Amith Shetty, N. G. K. B. M. V. (2012). "Senior Streaming Assessment Further Evaluation after Triage zone: A novel model of care encompassing various emergency department throughput measures." Emergency medicine Australasia: 374-82. Dover, N. (2012). "Caring for patients in the right place at the right time." 1(3): 30-6. Olaussen, A., et al. (2021). "Paramedic streaming upon arrival in emergency department: A prospective study." Emergency Medicine Australasia 33(2): 286-291. Pierce, B. A. and Gormley, D. (2016). "Are Split Flow and Provider in Triage Models in the Emergency Department Effective in Reducing Discharge Length of Stay?" 1(6): 487-491. Smith, B. and Burscough, S. (2015). "Developing a programme of patient 'streaming' in an emergency department." International Journal of Orthopaedic & Trauma Nursing 19(2): 85-91. van der Linden, C., et al. (2012). "Managing patient flow with triage streaming to identify patients for Dutch emergency nurse practitioners." International Emergency Nursing 20(2): 52-57.
Symptom Assessment Application (SAA)	Cotte, F., et al. (2022). "Safety of Triage Self-assessment Using a Symptom Assessment App for Walk-in Patients in the Emergency Care Setting: Observational Prospective Cross-sectional Study." JMIR MHealth and UHealth 10(3): e32340.
Taiwan Prehospital Triage System (TPTS)	Tsai, L. H., et al. (2017). "Comparison of prehospital triage and five-level triage system at the emergency department." 1(11): 720-725.
Taiwan Triage and Acuity Scale (TTAS)	Chip-Jin Ng, et al. (2019). "Validation of the five-tier Taiwan Triage and Acuity Scale for prehospital use by Emergency Medical Technicians." Emergency Medicine

Tool	Citations
	Journal: 472-478. Tsai, L. H., et al. (2017). "Comparison of prehospital triage and five-level triage system at the emergency department." 1(11): 720-725.
Telemedical physician triage (Telemedicine)	Tolia, V., et al. (2017). "EDTITRATE (Emergency Department Telemedicine Initiative to Rapidly Accommodate in Times of Emergency)." Journal of Telemedicine & Telecare 23(4): 484-488. Traub, S. J., et al. (2013). "Emergency department physician telemedical triage." 1(11): 841-5.
Three-level triage scale (TLTS, modified ATS)	Lam, R. P. K., et al. (2020). "Performance of a three-level triage scale in live triage encounters in an emergency department in Hong Kong." International Journal of Emergency Medicine 13(1): 1-8.
Triage Information Mortality Model (TIMM)	Teubner, D. J. O., et al. (2015). "Model to predict inpatient mortality from information gathered at presentation to an emergency department: The Triage Information Mortality Model (TIMM)." Emergency Medicine Australasia 27(4): 300-306.
Triage Risk Stratification Tool (TRST)	Cousins, G., et al. (2013). "Adverse outcomes in older adults attending emergency department: systematic review and meta-analysis of the Triage Risk Stratification Tool. [Review]." 1(4): 230-9.
Vitalpac Early Warning Score (VEWS)	Martin-Rodriguez, F., et al. (2021). "The Value of Prehospital Early Warning Scores to Predict in - Hospital Clinical Deterioration: A Multicenter, Observational Base-Ambulance Study." Prehospital Emergency Care 25(5): 597-606.
WEst coast System for Triage (WEST)	Habbouche, S., et al. (2022). "Comparison of the novel WEst coast System for Triage (WEST) with Rapid Emergency Triage and Treatment System (RETTS©): an observational pilot study." International Journal of Emergency Medicine 15(1): 1-10.

Appendix 7: Citations of studies reporting on the implementation of models/systems/tools

McCabe, C., et al. (2019). "The introduction of the Early Warning Score in the Emergency Department: A retrospective cohort study." International emergency nursing 45: 31-35.

Shea, S. S. and Hoyt, K. S. (2012). ""RAPID" team triage: one hospital's approach to patient-centered team triage." 1(2): 177-89.

Whitfield, C. G. (2013). Emergency department triage acuity ratings: Embedding ESI into the electronic medical record. University of South Carolina. 208 p-208 p.

Appendix 8: Evidence on each model/system/tool

7.1 Australasian Triage Scale (ATS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Aeimchanbanjong et al. (2017)	1041 children <15 years attending ED in Thailand in 2015	Compared with clinical outcome	Ability to predict admission	ATS: 13%	ATS: 94%	NA	NA	**AUC of ROC** ATS: 0.73 (0.69 to 0.77)	*Reliability (compared between rater)* **Reliability between doctor and doctor** ATS: κ 0.69 **Reliability between nurse and nurse** ATS: κ 0.68 **Reliability between doctor and nurse** ATS: κ 0.55
Ebrahimi et al. (2020)	A meta-analytic review of 13 studies with a total of 29,094 children attending EDs in five countries (Australia, Canada, Iran, Netherlands and the USA) in 2002-15	NA	NA	NA	NA	NA	NA	NA	*Reliability (based on weighted kappa) (compared between rater)* **Reliability of paediatric triage scales (pooled correlation coefficients):** ATS: 0.25 (0.202 to 0.297)
Hinson et al. (2019)	Systematic review of 50 studies (1999-2017) with 50 to 549,351 patients attending	Compared with clinical outcome	ED Mortality	ATS: 0.75 (Severe Sepsis)	ATS: 0.59 (Severe Sepsis)	NA	NA	NA	*Reliability (based on unweighted kappa) (compared between rater)* **Reliability in paper scenarios (nurse)** ATS: 0.41
		Compared	In-Hospital	ATS: 0.34	ATS: 0.94	NA	NA	NA	

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
	EDs in 16 countries incl Canada & Australia	with clinical outcome	Mortality	(General)	(General)				*Reliability (based on unweighted kappa) (compared with criterion standard)* **Reliability in paper scenarios (nurse)** ATS: 0.43
		Compared with clinical outcome	Hospitalisation at High Acuity Level 1 or 2	ATS: 0.18 (General)	ATS: 0.97 (General)	NA	NA	NA	
		Compared with clinical outcome	Hospitalisation at Mid-Acuity Level 1 through 3	ATS: 0.58 (General)	ATS: 0.81 (General)	NA	NA	NA	

7.2 Canadian Triage and Acuity Scale (CTAS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Aeimchanbanjong et al. (2017)	1041 children <15 years attending ED in Thailand in 2015	Compared with clinical outcome	Ability to predict admission	CTAS: 50%	CTAS: 74%	NA	NA	**AUC of ROC** CTAS: 0.64 (0.59 to 0.70)	*Reliability (compared between rater)* **Reliability between doctor and doctor** CTAS: κ 0.818 **Reliability between nurse and nurse** CTAS: κ 0.72 **Reliability between doctor and nurse** CTAS: κ 0.81
Ebrahimi et al. (2020)	A meta-analytic review of 13 studies with a total of 29,094 children attending	NA	NA	NA	NA	NA	NA	NA	*Reliability (based on weighted kappa) (compared between rater)* **Reliability of paediatric triage scales (pooled correlation coefficients):**

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
	EDs in five countries (Australia, Canada, Iran, Netherlands and the USA) in 2002-15								CTAS: 0.571 (0.372 to 0.720)
Hinson et al. (2019)	Systematic review of 50 studies (1999-2017) with 50 to 549,351 patients attending EDs in 16 countries incl Canada & Australia	Compared with clinical outcome	ED Mortality	CTAS: 0.78 (General), 1.00 (Paediatric), 1.00 (Elderly)	CTAS: 0.96 (General), 0.99 (Paediatric), 0.85 (Elderly)	NA	NA	NA	*Reliability (based on unweighted kappa) (compared between rater)* **<u>Reliability in patient encounters (nurse)</u>** CTAS: 0.40 *Reliability (based on unweighted kappa) (compared with criterion standard)* **<u>Reliability in paper scenarios (nurse)</u>** CTAS: 0.46 *Reliability (based on weighted kappa: linear or quadratic) (compared between rater)* **<u>Reliability in patient encounters (nurse)</u>** CTAS: 0.52 (linear), 0.65 to 0.66 (quadratic) **<u>Reliability in paper scenarios (nurse)</u>** CTAS: 0.70 (linear), 0.79 to 0.87
		Compared with clinical outcome	In-Hospital Mortality	CTAS: 0.64 (Elderly)	CTAS: 0.81 (Elderly)	NA	NA	NA	
		Compared with clinical outcome	1-Day Mortality	CTAS: 0.70 (Heart Failure)	CTAS: 0.57 (Heart Failure)	NA	NA	NA	
		Compared with clinical outcome	ICU Admission	CTAS: 0.79 (Paediatric), 0.80 (Elderly), 0.63 (Heart Failure)	CTAS: 0.88 (Paediatric), 0.93 (Elderly), 0.59 (Heart Failure)	NA	NA	NA	
		Compared with clinical outcome	Immediate Life-Saving Intervention	CTAS: 0.98 (Elderly)	CTAS: 0.89 (Elderly)	NA	NA	NA	

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
		Compared with clinical outcome	Hospitalisation at High Acuity Level 1 or 2	CTAS: 0.18 to 0.44 (General), 0.09 to 0.45 (Paediatric), 0.28 (Elderly)	CTAS: 0.80 to 0.98 (General), 0.91 to 0.99 (Paediatric), 0.96 (Elderly)	NA	NA	NA	(quadratic) *Reliability (based on weighted kappa: linear or quadratic) (compared with criterion standard)* **Reliability in paper scenarios (nurse)** CTAS: 0.71 (unknown)
		Compared with clinical outcome	Hospitalisation at Mid-Acuity Level 1 through 3	CTAS: 0.69 to 0.85 (General), 0.55 to 0.91 (Paediatric), 0.92 (Elderly)	CTAS: 0.34 to 0.80 (General), 0.52 to 0.86 (Paediatric), 0.38 (Elderly)	NA	NA	NA	
Lin et al. (2013)	37,416 patients triaged as CTAS level 5 at EDs in Canada in 2002-09	NA	NA	NA	NA	NA	NA	NA	*Reliability (compared between rater)* Reliability between nurse CTAS assignments and the original triage assignment of CTAS level 5 for admitted patients (95% CI): κ -0.9 (-0.96 to -0.84) Reliability among nurses: 95.8%
Zachariasse et al. (2019)	A systematic review and meta-analysis of 66 studies with a median sample size of 1496 in children, 1447 in adults and 929 in elderly attending	Compared with clinical outcome	Ability to identify high-urgency patients (ICU admission)	CTAS: 0.67 to 0.93 (children)	CTAS: 0.88 to 0.94 (children)	NA	NA	NA	NA
			Ability to identify low-urgency patients	CTAS: 0.13 to 0.59 (children), 0.27 to 0.44	CTAS: 0.74 to 0.96 (children), 0.80 to 0.92	NA	NA	NA	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
	EDs in higher income countries published from 1980 to 2018		(discharge home after the ED visit)	(adults/ unspecified)	(adults/ unspecified)				

7.3 Emergency Severity Index (ESI)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Aeimchanbanjong et al. (2017)	1041 children <15 years attending ED in Thailand in 2015	Compared with clinical outcome	Ability to predict admission	ESI: 52%	ESI: 81%	NA	NA	**AUC of ROC** ESI: 0.78 (0.73 to 0.81)	*Reliability (compared between rater)* **Reliability between doctor and doctor** ESI: κ 0.81 **Reliability between nurse and nurse** ESI: κ 0.73 **Reliability between doctor and nurse** ESI: κ 0.9

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
de Magalhães-Barbosa et al. (2017)	Systematic review of 25 studies with a total of 973,099 children attending EDs in 11 countries including Canada and England published in 2005-14	Compared with clinical outcome	Association with hospital admission	NA	NA	NA	NA	Overtriage: 16% Undertriage: 11% (Overtriage: ESI level 1,2 or 3 who used <2 resources, or ESI level 1 not admitted to hospital. Under-triage: ESI level 4 or 5 who used ≥2 resources or admitted to hospital	NA
Ebrahimi et al. (2020)	A meta-analytic review of 13 studies with a total of 29,094 children attending EDs in five countries (Australia, Canada, Iran, Netherlands and the USA) in 2002-15	NA	NA	NA	NA	NA	NA	NA	*Reliability* *(based on weighted kappa) (compared between rater)* **Reliability of paediatric triage scales (pooled correlation coefficients):** ESI: 0.810 (0.711 to 0.877)
Green et al. (2012)	100 children attending a paediatric ED in the United States in 2010	NA	NA	NA	NA	NA	NA	NA	*Reliability (compared between rater)* Reliability among nurses: k 0.92 (0.86 to 0.98), intraclass correlation coefficient 0.96 (0.95 to 0.97), *P*<0.001 Reliability between nurses and physicians:

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
									k 0.78 (0.68 to 0.88), intraclass correlation coefficient 0.91 (0.87 to 0.94), *P*<0.001
Hinson et al. (2019)	Systematic review of 50 studies (1999-2017) with 50 to 549,351 patients attending EDs in 16 countries incl Canada & Australia	Compared with clinical outcome	ED Mortality	ESI: 0.93 (General), 1.00 (Elderly)	ESI: 0.88 (General), 0.80 (Elderly)	NA	NA	NA	*Reliability (based on unweighted kappa) (compared between rater)* **Reliability in paper scenarios (nurse)** ESI: 0.46 *Reliability (based on unweighted kappa) (compared with criterion standard)* **Reliability in patient encounters (nurse)** ESI: 0.70 to 0.77 **Reliability in paper scenarios (nurse)** ESI: 0.43 *Reliability (based on weighted kappa: linear or quadratic) (compared between rater)* **Reliability in patient encounters (nurse)** ESI: 0.78 (unknown) **Reliability in paper scenarios (nurse)** ESI: 0.73 (quadratic), 0.76 to 0.80 (unknown) *Reliability (based on weighted kappa: linear or quadratic) (compared with*
		Compared with clinical outcome	In-Hospital Mortality	ESI: 0.64 (Elderly)	ESI: 0.81 (Elderly)	NA	NA	NA	
		Compared with clinical outcome	ICU Admission	ESI: 1.00 (Paediatric)	ESI: 0.71 (Paediatric)	NA	NA	NA	
		Compared with clinical outcome	Immediate Life-Saving Intervention	ESI: 0.77 to 0.85 (Elderly)	ESI: 0.77 to 0.82 (Elderly)	NA	NA	NA	
		Compared with clinical outcome	Hospitalisation at High Acuity Level 1 or 2	ESI: 0.28 to 0.68 (General), 0.41 to 0.93 (Paediatric), 0.67 (Elderly)	ESI: 0.84 to 0.93 (General), 0.78 to 0.94 (Paediatric), 0.76 (Elderly)	NA	NA	NA	
		Compared with clinical outcome	Hospitalisation at Mid-Acuity Level 1 through 3	ESI: 0.86 to 0.97 (General), 0.82 to 0.95 (Paediatric), 0.98 (Elderly)	ESI: 0.54 to 0.67 (General), 0.59 to 0.68 (Paediatric), 0.30 (Elderly)	NA	NA	NA	

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
									criterion standard) **Reliability in patient encounters (nurse)** ESI: 0.80 (linear), 0.81 to 0.86 (quadratic), 0.68 to 0.99 (unknown) **Reliability in paper scenarios (nurse)** ESI: 0.71 (quadratic)
Hong et al. (2015)	233 adults attending ED in the United States in 2011	Compared with clinical outcome	Presence of abnormal vital signs	ESI: 87.8% (75.4% to 94.6%)	ESI: 15.2% (10.7% to 21.2%)	NA	NA	NA	NA
			Need for an emergent intervention	ESI: 95.2% (75.6% to 99.9%)	ESI: 15.6% (11.3% to 21.2%)	NA	NA	NA	NA
			Admission status	ESI: 97.9% (92.3% to 99.9%)	ESI: 23.4% (17.0% to 31.2%)	NA	NA	NA	NA
Zachariasse et al. (2019)	A systematic review and meta-analysis of 66 studies with a median sample size of 1496 in children, 1447 in adults and 929 in elderly attending EDs in higher income countries published from 1980 to 2018	Compared with clinical outcome	Ability to identify high-urgency patients (ICU admission)	ESI: 0.83 to 0.88 (adults/ unspecified)	ESI: 0.59 to 0.82 (adults/ unspecified)	NA	NA	NA	NA
			Ability to identify low-urgency patients (discharge home after the ED visit)	ESI: 0.41 to 0.85 (children), 0.08 to 0.65 (adults/ unspecified)	ESI: 0.80 to 0.94 (children), 0.64 to 0.98 (adults/ unspecified)	NA	NA	NA	NA

7.4 Expert Practitioner

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Wiswell et al. (2013)	178 adults (with a total of 266 observations) attending ED in the United States (data collection period unclear, published in 2013	Compared with clinical outcome	Ability to predict disposition (discharge home vs hospital admission)	All physicians: 87.7% (81.4% to 92.1%) Attendings: 92.3% (81.8% to 97.0%) Residents: 85.1% (76.5% to 90.9%)	All physicians: 65.0% (56.1% to 72.9%) Attendings: 73.3% (59.0% to 84.0%) Residents: 60.0% (48.7% to 70.3%)	NA	All physicians: LR (+): 2.51 (1.95 to 3.22) LR (-): 0.19 (0.12 to 0.30) Attendings: LR (+): 3.46 (2.12 to 5.66) LR (-): 0.11 (0.04 to 0.27) Residents: LR (+): 2.13 (1.59 to 2.84) LR (-): 0.25 (0.15 to 0.42)	Overall: correctly predicted in 77% of observations	NA
			Ability to predict disposition (Non-intensive care unit [ICU] vs ICU)	All physicians: 60.0% (42.3% to 75.4%) Attendings: 77.8% (45.3% to 93.7%) Residents: 52.4% (32.4% to 71.7%)	All physicians: 95.9% (90.0% to 98.4%) Attendings: 94.9% (83.1% to 98.6%) Residents: 96.6% (88.5% to 99.1%)	NA	All physicians: LR (+): 14.7 (5.39 to 40.1) LR (-): 0.42 (0.27 to 0.65) Attendings: LR (+): 15.2 (3.76 to 61.16) LR (-): 0.23 (0.07 to 0.80) Residents: LR	NA	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
							(+): 15.5 (3.73 to 64.1) LR (-): 0.49 (0.31 to 0.77)		
			Ability to predict patient acuity (sick vs not sick)	All physicians: 66.2% (55.1% to 75.8%) Attendings: 73.1% (53.9% to 86.3%) Residents: 62.7% (49.0% to 74.7%)	All physicians: 88.4% (83.0% to 92.2%) Attendings: 83.1% (72.7% to 90.1%) Residents: 91.5% (85.1% to 95.3%)	All physicians: PPV: 69.9% (58.6% to 79.2%) NPV: 86.5% (81.0% to 90.6%) Attendings: PPV: 61.3% (43.8% to 76.3%) NPV: 89.4% (79.7% to 94.8%) Residents: PPV: 76.2% (61.5% to 86.5%) NPV: 85.0% (77.8% to 90.2%)	All physicians: LR (+): 5.69 (3.72 to 8.69) LR (-): 0.38 (0.28 to 0.53) Attendings: LR (+): 4.32 (2.46 to 7.62) LR (-): 0.32 (0.17 to 0.62) Residents: LR (+): 7.40 (3.95 to 13.90) LR (-): 0.41 (0.28 to 0.58)	Overall: correctly predicted in 82% of observations	NA

7.5 Hong Kong 3-level Triage Scale (HK3TS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Lam et al. (2020)	151 patients (104 adults and 47 children) attending ED in Hong Kong in 2019	Compared with clinical outcome	Ability to identify patients who required earlier medical attention	68.2% (45.1% to 86.1%)	99.2% (95.8% to 100%)	PPV: 93.8% (67.6% to 99.1%) NPV: 94.8% (90.8% to 97.1%)	NA	Overtriage rate: 0.7% Undertriage rate: 4.6%	*Reliability (based on quadratic-weighted kappa) (compared with criterion standard)* Reliability between the triage nurse and criterion standard (95% CI): k 0.76 (0.60 to 0.92), p<0.001 *Reliability (based on quadratic-weighted kappa) (compared between rater)* Reliability across nurses (95%CI): k 0.81 (0.65 to 0.97), p<0.001

7.6 Illness Rating Score (IRS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
O'Neill et al. (2021)	141 children attending a paediatric ED with medical complaints and Emergency Severity Index triage levels of 2 and 3 in the	Compared with clinical outcome	Ability to predict admission	IRS >1: 88% IRS >2: 72% IRS >3: 65% IRS >4: 58% IRS >5: 49% IRS >6: 31% IRS >7: 19% IRS >8: 4%	IRS >1: 12% IRS >2: 36% IRS >3: 57% IRS >4: 71% IRS >5: 76% IRS >6: 87% IRS >7: 95% IRS >8: 100%	IRS >1: PPV: 36% NPV: 65% IRS >2: PPV: 39% NPV: 70% IRS >3: PPV: 46%	NA	AUC of ROC: 0.635 (0.534 to 0.737) **% Correct Classification** IRS >1: 40% IRS >2: 50% IRS >3: 60% IRS >4: 67%	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
	United States in 2019					NPV: 74% IRS >4: PPV: 54% NPV: 75% IRS >5: PPV: 53% NPV: 72% IRS >6: PPV: 57% NPV: 69% IRS >7: PPV: 67% NPV: 67% IRS >8: PPV: 100% NPV: 65%		IRS >5: 66% IRS >6: 67% IRS >7: 67% IRS >8: 65%	

7.7 Modified Early Warning Score (MEWS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Bulut et al. (2014)	2000 adults attending EDs in Turkey in 2011-12	Compared with clinical outcome	Ability to predict admission	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.568 (0.546 to 0.590), p<0.001	NA
			Ability to	NA	NA	NA	NA	**AUC of ROC**	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
			predict admission to intensive care unit (ICU)/high dependency unit (HDU)					MEWS: 0.538 (0.516 to 0.560), p=0.009	
			Ability to predict in-hospital mortality	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.630 (0.608 to 0.651), p<0.001	NA
Lee et al. (2020)	81,520 adults attending ED in Korea in 2010-17	Compared with clinical outcome	Ability to predict mortality within 24 h (Derivation group)	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.857 (0.854 to 0.860) **AUC difference** Between TREWS and MEWS: 0.049 (0.041 to 0.057), p<0.001	NA
			Ability to predict mortality within 24 h (Validation group)	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.865 (0.861 to 0.869) **AUC difference** Between TREWS and MEWS: 0.045 (0.035 to 0.055), p<0.001	NA
			Ability to predict mortality	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.851 (0.846 to 0.855)	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
			within 48 h (Validation group)					**AUC difference** Between TREWS and MEWS: 0.048 (0.039 to 0.058), p<0.001	
Schinkel et al. (2022)	12,317 adults attending ED in the Netherlands in 2018-20	Compared with clinical outcome	Ability to predict hospital admission	NA	NA	NA	NA	**AUC of ROC** MEWS: 0.65 (0.65 to 0.66), p<0.001	NA

7.8 Modified Manchester Triage System (mMTS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)

de Magalhães-Barbosa et al. (2017)	Systematic review of 25 studies with a total of 973,099 children attending EDs in 11 countries including Canada and England published in 2005-14	Expert-developed reference standard	Ability to detect high urgency	64%	87%	NA	NA	Absolute agreement: 37% Overtriage: 47% Undertriage: 15% Diagnostic OR of high urgency: 11.5	NA

7.9 Modified Paediatric Early Warning Score (MPEWS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Vredebregt et al. (2019)	2812 children <16 years attending ED in the Netherlands in 2015-16	Compared with clinical outcome	Ability to predict ICU admission	MPEWS ≥4: 80% (44% to 96%) MPEWS ≥5: 80% (44% to 96%) MPEWS ≥6: 70% (35% to 92%) MPEWS ≥7: 60% (27% to 86%)	MPEWS ≥4: 77% (75% to 78%) MPEWS ≥5: 85% (83% to 86%) MPEWS ≥6: 90% (88% to 91%) MPEWS ≥7: 94% (93% to 95%)	MPEWS ≥4: PPV: 1.2% (0.5% to 2.4%) NPV: 100% (99.6% to 100%) MPEWS ≥5: PPV: 1.8% (0.8% to 3.7%) NPV: 100% (99.7% to 100%)	NA	**AUC of ROC** MPEWS ≥4: 0.78 (0.64 to 0.93), p=0.002 MPEWS ≥5: 0.82 (0.68 to 0.97), p<0.001 MPEWS ≥6: 0.80 (0.63 to 0.97), p=0.001 MPEWS ≥7: 0.77 (0.59 to 0.96), p=0.003 MPEWS (no	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
						MPEWS ≥6: PPV: 2.3% (1.0% to 5.0%) NPV: 100% (99.6% to 100%) MPEWS ≥7: PPV: 3.5% (1.4% to 7.9%) NPV: 99.8% (99.6% to 100%)		cutoff): 0.85 (0.68 to 1.00), p<0.001 Model with MPEWS (no cutoff) and MTS: 0.92 (0.84 to 1.00), p<0.001 Model with MPEWS ≥5 and MTS: 0.89 (0.77 to 1.00), p<0.001	
			Ability to predict hospitalization	NA	NA	NA	NA	**Maximum AUROC** MPEWS: 0.57 (0.55 to 0.59)	NA

7.10 Manchester Triage System (MTS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Aeimchanbanjong et al. (2017)	1041 children <15 years attending ED in Thailand in 2015	Compared with clinical outcome	Ability to predict admission	MTS: 57%	MTS: 69%	NA	NA	**AUC of ROC** MTS: 0.70 (0.66 to 0.744)	*Reliability (compared between rater)* **Reliability between doctor and doctor** MTS: κ 0.72 **Reliability between nurse and nurse** MTS: κ 0.61 **Reliability between doctor and nurse** MTS: κ 0.56
de Magalhães-Barbosa et al. (2017)	Systematic review of 25 studies with a total of 973,099 children attending EDs in 11 countries including Canada and England published in 2005-14	Expert-developed reference standard	Ability to detect high urgency	63%	78% to 79%	NA	LR (+): 3.0 LR (-): 0.47	Absolute agreement: 34% to 45% Overtriage: 40% to 54% Undertriage: 12% to 15%	NA
			Percentage of undertriage in levels 1 and 2	NA	NA	NA	NA	Percentage of undertriage in levels 1 & 2: 2% Percentage of undertriage >1 category: 0.9% Percentage of serious under-triage according to experts: 0.65%	NA
			Ability to detect high urgency in febrile patients with chronic disease vs	58% vs 74%	78% vs 75%	NA	LR (+): 2.6 vs 1.1 LR (-): 0.71 vs 0.80	Absolute agreement: 35% vs 30% Overtriage: 48% vs 59%	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
			without chronic disease					Undertriage: 17% vs 11% Diagnostic OR of high urgency: 4.8 vs 8.7	
		Compared with clinical outcome	Ability to detect serious bacterial infection	42%	69%	PPV: 14% NPV: 91%	LR (+): 1.35 LR (-): 0.84	AUC: 0.57	NA
Ebrahimi et al. (2020)	A meta-analytic review of 13 studies with a total of 29,094 children attending EDs in five countries (Australia, Canada, Iran, Netherlands and the USA) in 2002-15	NA	NA	NA	NA	NA	NA	NA	*Reliability* *(based on weighted kappa) (compared between rater)* **Reliability of paediatric triage scales (pooled correlation coefficients):** MTS: 0.755 (0.522 to 0.883)
Hinson et al. (2019)	Systematic review of 50 studies (1999-2017) with 50 to 549,351 patients attending EDs in 16 countries incl Canada & Australia	Compared with clinical outcome	ED Mortality	MTS: 0.97 to 0.98 (General)	MTS: 0.74 to 0.83 (General)	NA	NA	NA	*Reliability (based on unweighted kappa) (compared between rater)* **Reliability in paper scenarios (nurse)** MTS: 0.76 *Reliability (based on unweighted kappa) (compared with criterion standard)* **Reliability in paper scenarios (nurse)** MTS: 0.48 to 0.84
		Compared with clinical outcome	In-Hospital Mortality	MTS: 0.39 to 0.69 (General), 0.73 (Pulmonary Embolism)	MTS: 0.74 to 0.85 (General), 0.50 (Pulmonary Embolism)	NA	NA	NA	
		Compared	ICU Admission	MTS: 0.58 to	MTS: 0.75 to	NA	NA	NA	

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
		with clinical outcome		0.82 (General), 0.71 (Paediatric)	0.84 (General), 0.83 (Paediatric)				*Reliability (based on weighted kappa: linear or quadratic) (compared between rater)* **<u>Reliability in patient encounters (nurse)</u>** MTS: 0.95 (unknown) **<u>Reliability in paper scenarios (nurse)</u>** MTS: 0.82 (quadratic), 0.60 (unknown) *Reliability (based on weighted kappa: linear or quadratic) (compared with criterion standard)* **<u>Reliability in paper scenarios (nurse)</u>** MTS: 0.71 (linear), 0.62 to 0.87 (quadratic)
		Compared with clinical outcome	Hospitalisation at High Acuity Level 1 or 2	MTS: 0.37 to 0.59 (General), 0.70 (Paediatric)	MTS: 0.78 to 0.93 (General), 0.70 (Paediatric)	NA	NA	NA	
		Compared with clinical outcome	Hospitalisation at Mid-Acuity Level 1 through 3	MTS: 0.85 to 0.96 (General), 0.91 (Paediatric)	MTS: 0.25 to 0.54 (General), 0.44 (Paediatric)	NA	NA	NA	
Vredebregt et al. (2019)	2812 children <16 years attending ED in the Netherlands in 2015-16	Compared with clinical outcome	Ability to predict ICU admission	NA	NA	NA	NA	**<u>AUC of ROC</u>** MTS (categorical): 0.82 (0.68 to 0.95), p<0.001 Model with MPEWS (no cutoff) and MTS: 0.92 (0.84 to 1.00), p<0.001 Model with MPEWS ≥5 and	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
								MTS: 0.89 (0.77 to 1.00), p<0.001	
Zachariasse et al. (2019)	A systematic review and meta-analysis of 66 studies with a median sample size of 1496 in children, 1447 in adults and 929 in elderly attending EDs in higher income countries published from 1980 to 2018	Compared with clinical outcome	Ability to identify high-urgency patients (ICU admission)	MTS : 0.71 (children), 0.58 to 0.83 (adults/ unspecified)	MTS: 0.83 (children), 0.75 to 0.84 (adults/ unspecified)	NA	NA	NA	NA
			Ability to identify low-urgency patients (discharge home after the ED visit)	MTS: 0.43 to 0.70 (children), 0.37 to 0.59 (adults/ unspecified)	MTS: 0.69 to 0.86 (children), 0.78 to 0.93 (adults/ unspecified)	NA	NA	NA	NA

7.11 National Early Warning Score (NEWS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Lee et al. (2020)	81,520 adults attending ED in Korea in 2010-17	Compared with clinical outcome	Ability to predict mortality within 24 h (Derivation group)	NA	NA	NA	NA	**AUC of ROC** NEWS: 0.878 (0.875 to 0.881) **AUC difference** Between TREWS and NEWS: 0.028 (0.022 to 0.033), p<0.001	NA
			Ability to	NA	NA	NA	NA	**AUC of ROC**	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
			predict mortality within 24 h (Validation group)					NEWS: 0.884 (0.880 to 0.888) **AUC difference** Between TREWS and NEWS: 0.027 (0.020 to 0.033), p<0.001	
			Ability to predict mortality within 48 h (Validation group)	NA	NA	NA	NA	**AUC of ROC** NEWS: 0.874 (0.870 to 0.878) **AUC difference** Between TREWS and NEWS: 0.025 (0.018 to 0.031), p<0.001	NA

7.12 Netherlands Triage System (NTS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Schinkel et al. (2022)	12,317 adults attending ED in the Netherlands in 2018-20	Compared with clinical outcome	Ability to predict hospital admission	NA	NA	NA	NA	**AUC of ROC** NTS: 0.60 (0.60 to 0.61)	NA

7.13 Princess Marina Hospital Triage Scale (PATS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
de Magalhães-Barbosa et al. (2017)	Systematic review of 25 studies with a total of 973,099 children attending EDs in 11 countries including Canada and England published in 2005-14	Compared with clinical outcome	Association with hospital admission	NA	NA	NA	NA	Overtriage: 28.8% Undertriage: 21.9% (Overtriage: PATS level 1 or 2 not admitted to hospital, Under-triage: PATS level 4 admitted to hospital)	NA

7.14 Rapid Emergency Medicine Score (REMS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Bulut et al. (2014)	2000 adults attending EDs in Turkey in 2011-12	Compared with clinical outcome	Ability to predict admission	NA	NA	NA	NA	**AUC of ROC** REMS: 0.642 (0.621 to 0.663), $p<0.001$	NA
			Ability to predict admission to intensive care unit (ICU)/high dependency	NA	NA	NA	NA	**AUC of ROC** REMS: 0.589 (0.567 to 0.611), $p<0.001$	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
			unit (HDU)						
			Ability to predict in-hospital mortality	NA	NA	NA	NA	**AUC of ROC** REMS: 0.707 (0.686 to 0.727), p<0.001	NA
Lee et al. (2020)	81,520 adults attending ED in Korea in 2010-17	Compared with clinical outcome	Ability to predict mortality within 24 h (Derivation group)	NA	NA	NA	NA	**AUC of ROC** REMS: 0.834 (0.831 to 0.837) **AUC difference** Between TREWS and REMS: 0.072 (0.063 to 0.080), p<0.001	NA
			Ability to predict mortality within 24 h (Validation group)	NA	NA	NA	NA	**AUC of ROC** REMS: 0.825 (0.820 to 0.829) **AUC difference** Between TREWS and REMS: 0.085 (0.072 to 0.098), p<0.001	NA
			Ability to predict mortality within 48 h (Validation group)	NA	NA	NA	NA	**AUC of ROC** REMS: 0.815 (0.810 to 0.819) **AUC difference** Between TREWS and REMS: 0.084 (0.073 to 0.096), p<0.001	NA

7.15 Ramathibodi Triage System (RTS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Aeimchanbanjong et al. (2017)	1041 children <15 years attending ED in Thailand in 2015	Compared with clinical outcome	Ability to predict admission	RTS: 64%	RTS: 64%	NA	NA	**AUC of ROC** RTS: 0.66 (0.60 to 0.70)	*Reliability (compared between rater)* **Reliability between doctor and doctor** RTS: κ 1 **Reliability between nurse and nurse** RTS: κ 1 **Reliability between doctor and nurse** RTS: κ 1

7.16 South African Triage Scale (SATS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
de Magalhães-Barbosa et al. (2017)	Systematic review of 25 studies with a total of 973,099 children attending EDs in 11 countries including Canada and England published in 2005-14	Compared with clinical outcome	Ability to predict hospital admission	91%	54.5%	PPV: 37.5% NPV: 95.3%	NA	Overtriage: 45.5% Undertriage: 9%	NA
Hinson et al. (2019)	Systematic review of 50 studies with a range of 50 to 549,351 patients attending EDs in 16 countries including Canada and Australia published between 1999 to 2017	NA	NA	NA	NA	NA	NA	NA	*Reliability (based on unweighted kappa) (compared between rater)* **Reliability in paper scenarios (nurse)** SATS: 0.55 *Reliability (based on weighted kappa: linear or quadratic) (compared between rater)* **Reliability in paper scenarios (nurse)** SATS: 0.65 (linear), 0.77 (quadratic) *Reliability (based on weighted kappa: linear or quadratic) (compared with criterion standard)*

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
									Reliability in patient encounters (nurse) SATS: 0.92 (quadratic)

7.17 Triage in Emergency Department Early Warning Score (TREWS)

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
Lee et al. (2020)	81,520 adults attending ED in Korea in 2010-17	Compared with clinical outcome	Ability to predict mortality within 24 h (Derivation group)	NA	NA	NA	NA	**AUC of ROC** TREWS: 0.906 (0.903 to 0.908) **AUC difference** Between TREWS and NEWS: 0.028 (0.022 to 0.033), p<0.001 Between TREWS and MEWS: 0.049 (0.041 to 0.057), p<0.001 Between TREWS and REMS: 0.072 (0.063 to 0.080), p<0.001	NA
			Ability to predict mortality within 24 h (Validation group)	NA	NA	NA	NA	**AUC of ROC** TREWS: 0.910 (0.907 to 0.914) **AUC difference** Between TREWS and NEWS: 0.027	NA

Study	Population	Comparator	Outcome assessed	Sensitivity (95% CI)	Specificity (95% CI)	PPV/ NPV (95% CI)	Likelihood ratio (95% CI)	Other measure of effectiveness (95% CI)	Reliability (95% CI)
								(0.020 to 0.033), p<0.001 Between TREWS and MEWS: 0.045 (0.035 to 0.055), p<0.001 Between TREWS and REMS: 0.085 (0.072 to 0.098), p<0.001	
			Ability to predict mortality within 48 h (Validation group)	NA	NA	NA	NA	**AUC of ROC** TREWS: 0.899 (0.895 to 0.903) **AUC difference** Between TREWS and NEWS: 0.025 (0.018 to 0.031), p<0.001 Between TREWS and MEWS: 0.048 (0.039 to 0.058), p<0.001 Between TREWS and REMS: 0.084 (0.073 to 0.096), p<0.001	NA

7.18 Taiwan Triage and Acuity Scale (TTAS)

Study	Population	Comparator	Outcome	Sensitivity	Specificity	PPV/ NPV	Likelihood	Other measure	Reliability (95% CI)

			assessed	(95% CI)	(95% CI)	(95% CI)	ratio (95% CI)	of effectiveness (95% CI)	
Ng et al. (2019)	493 adults in the validation of triage scores in the field and 145 adults for inter-rater evaluation in the ED in Taiwan in 2014	NA	NA	NA	NA	NA	NA	NA	*Reliability (based on weighted kappa) (compared between rater)* Reliability between emergency medical technicians and triage registered nurses: κ 0.825 (0.750 to 0.900)

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