Safety and effectiveness of remote pre-hospital triage for appropriate emergency department attendances and service use

An evidence review

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Abbreviations

Abbreviation	Explanation
CI	confidence interval
COVID-19	coronavirus disease 2019
DANS	Data Archiving and Networked Services
DOH	Department of Health
ED	emergency department
GP	general practitioner
GRADE	Grading of Recommendations, Assessment, Development and Evaluations
HRB	Health Research Board
HTA	Health Technology Assessment
ID	identification
MeSH	Medical Subject Headings
NHLBI	National Heart, Lung, and Blood Institute
NHS	National Health Service
NPV	negative predictive value
N/A	not applicable
OECD	Organisation for Economic Co-operation and Development
OHS-PC	out-of-hours service in primary care
OOH-PC	out-of-hours primary care
OR	odds ratio
PCOOH	primary care out-of-hours
PICO	population, intervention, comparison, and outcomes
PPV	positive predictive value
PRISMA	Preferred Reporting Items for Systematic reviews and Meta-Analyses
RCT	randomised controlled trial
RD	risk difference
RoB 2	Version 2 of the Cochrane risk-of-bias tool for randomised trials
SMS	Short Messaging Service
SWiM	Synthesis Without Meta-analysis
TIDieR	Template for Intervention Description and Replication
UK	United Kingdom
USA	United States of America

Glossary of terms

Term	Explanation
active control	Active control (or active comparator) means that an already known, effective treatment (unlike a placebo) is being compared with an experimental treatment.
case resolution	Case resolution is defined, in this review, as evidence of no healthcare used within a given time period after being triaged to self-care.
cohort study	A cohort study is a form of longitudinal (analytic observational) epidemiological study in which a group of subjects, called a cohort, is followed over a period of time, and data relating to predetermined exposures and outcomes are collected on two or more occasions over this time period. The incidence (number of new cases) of the outcome(s) of interest is calculated in the exposed people and compared with the incidence in the non-exposed people. This comparison of incidence is known as relative risk. The data for the cohort can be collected either by following the participants into the future (prospective cohort study) or by asking them about their past (retrospective cohort study). However, retrospective cohort studies are limited by recall bias. One of the indicators of a high-quality cohort study is a loss to follow-up rate of less than 20%. Cohort studies contribute to causality or disease aetiology and provide, at most, moderate-quality evidence.
control	A control is used when conducting an experiment to test an element or intervention. It is the element that remains unchanged or unaffected by other variables. A control is the point of comparison against which other test results are measured.
ED avoidance	In this review we use the term ED avoidance to refer to cases where the triage service or triageur was able to direct to a triage disposition below ED, such as advice to attend GP, self-care, or other follow-up outside of ED (with range of options available depending on triage service and local healthcare system). Thus, ED avoidance does not refer to patient intentions or compliance but solely to the triage disposition assigned by the service.
false negative	A false negative is a negative test result in a person who possesses the attribute for which the test is conducted. It refers to the labelling of a diseased person as healthy when screening to detect a disease [1].
false positive	A false positive is a positive test result in a person who does not possess the attribute for which the test is conducted. It refers to the labelling of a healthy person as diseased when screening to detect a disease. This is calculated as the number of calls that are triaged as higher priority as a proportion of all calls known to not be a priority for ED treatment.
intubation	Intubation is a process where a healthcare provider inserts a tube through a person's mouth or nose, then down into their trachea (airway/windpipe). The tube keeps the trachea open so that air can get through.
mock or simulated patient	A mock or simulated patient is a vignette, scenario or trained individual designed to portray a patient in order to simulate a set of symptoms or problems and is used for healthcare education, evaluation, and research.

Term	Explanation
negative predictive value	The predictive value (of a screening or diagnostic test) is the probability of the disease being present given the results of the test. The predictive value of a test is determined by the sensitivity and specificity of the test and by the prevalence of the condition for which the test is used. The negative predictive value of a test is the probability that a person with a negative test result is a true negative (i.e. they do not have the disease).
overtriage	Overtriage is defined as a triage decision that classifies patients at a higher disposition/urgency level than what was needed.
placebo	Placebo is the name given to a substance which has no pharmacological effect but is administered as a control in testing the efficacy of a biologically active preparation. Common placebos include inert tablets (sugar pills) or inert injections (sterile water or saline) which are designed to look and feel like the active substance being tested but do not contain any active ingredients.
positive predictive value	The predictive value (of a screening or diagnostic test) is the probability of the disease being present given the results of the test. The predictive value of a test is determined by the sensitivity and specificity of the test and by the prevalence of the condition for which the test is used. The positive predictive value of a test is the probability that a person with a positive test result is a true positive (i.e. they do have the disease).
PROSPERO	International prospective register of systematic reviews
randomised controlled trial	A randomised controlled trial (RCT) is an analytic interventional epidemiological study in which subjects are randomly assigned to one of at least two groups. The first group is the experimental group that receives the intervention of interest, and the other group is the comparison or control group that receives an alternative treatment (current conventional therapy or placebo). The two groups are followed to see if there are any differences between them with respect to the outcome(s) of interest. The results of the RCT compare the incidence of success in the intervention group with the incidence of success in the control group in order to assess the effectiveness of the intervention. RCTs are the most stringent study design for evaluating the effect of an intervention on an outcome.
sensitivity	The sensitivity of a screening or diagnostic test is the probability that a diseased person (case) in the tested population will be identified as diseased by the test (true positive probability). Sensitivity is thus the probability of correctly diagnosing a case or the probability that any given case will be identified by the test (true positive rate).
specificity	The specificity of a screening or diagnostic test is the probability that a person without the disease will be correctly identified as not having the disease by the test (true negative probability). Specificity is thus the probability of correctly identifying a non-diseased person with a test (true negative rate).
surveillance system study	Public health surveillance is the ongoing systematic collection, analysis, interpretation, and dissemination of population-based data regarding a health-related event for use in public health action in order to reduce disease and death and to improve health. The fundamental principle of public health surveillance is that the surveillance should be designed and implemented in

Term	Explanation
	order to provide accurate and complete information to decision-makers in a timely manner at the lowest possible cost. A surveillance system study is based on a download and analysis of such information for a particular point or period in time [2]. Our definition of a surveillance system study for this review was one which: Included: • all users of a triage service in a given period (or a subset as per predefined criteria), with no consent required at the point of intervention • and a valid comparator (i.e. linked follow-up clinical data or an assessment using a validated tool); which was: o available either for the entire population, or for entire triage disposition categories; o or was based on observed presentations for the entire population in included hospital(s) in a given time frame, with no presentation presumed to indicate safe pre-hospital triage.
Template for Intervention Description and Replication	The Template for Intervention Description and Replication (TIDieR) checklist and guide was developed in order to improve the completeness of the reporting – and, ultimately, the replicability – of interventions, and the 12 items on the checklist are suitable to capture the core components of complex interventions. The 12-item TIDieR checklist is detailed in Table 2.
triage	Triage is the process of selecting for care or treatment the patients of highest priority or, when resources are limited, those thought most likely to benefit from care or treatment. The term 'triage' comes from the French '*trier*', which means to separate or to choose.
triage disposition	Triage disposition refers to where a patient is advised to go for care after being assessed by the triageur. Generally, triage dispositions range from high urgency (e.g. the need for an ambulance or to self-present to ED), down to moderate urgency (e.g. primary care out-of-hours appointment), and finally down to low urgency (e.g. self-care, attending one's own general practitioner, or making a scheduled primary care appointment). However, triage dispositions vary by triage service used and country.
true positive	See 'sensitivity'.
true negative	See 'specificity'.
undertriage	Undertriage is defined as a triage decision that classifies patients at a lower disposition/urgency level than what was needed.

Executive summary

Policy context

In Ireland, emergency department (ED) attendance increased by 13.3% between 2012 and 2021. By the end of December 2021, just under 1.45 million ED attendances were recorded in Ireland for that year. Remote pre-hospital triage strategies are currently being considered in order to reduce unnecessary ED attendance in Ireland and to fulfil two of the Department of Health's (DOH's) strategic priories. A review on this topic is required in order to synthesise the existing evidence related to the safety and effectiveness of remote pre-hospital triage services. This review will support the work of the Unscheduled Care Performance Management Board sub-group in identifying whole-system mitigations for ED overcrowding. The findings will be shared with the Health Service Executive in the context of the development of the 3-year Unscheduled Care Performance Improvement Plan.

Research question

The following research question was agreed in collaboration with the DOH:

- Are remote pre-hospital triage services safe for adults seeking unscheduled care, and where safe, are they effective in reducing ED attendance appropriately?

Methods

Following the recommended approach for systematic reviews, we developed a structured database search. Using a population, intervention, comparison, and outcomes (PICO) framework, the search concepts were broadly based on 'triage', 'emergency', and 'remote'. Pre-hospital triage services provided remotely for the initial assessment and management of unscheduled care focused on a clinical care issue for any conditions and operated by any staff and/or technology were included.

In June 2023, we searched a wide range of bibliographic databases and grey literature resources using structured and comprehensive search strategies in order to locate primary quantitative evidence published between 1997 and June 2023. No language limitations were applied, but the results of our primary and supplemental searches were predominantly in the English language. We imported the search results into EndNote reference management software for deduplication. We then transferred the records to the EPPI-Reviewer Web review management software and conducted further deduplication. We conducted screening in duplicate at the title and abstract level, and subsequently on eligible full-text papers. We also performed backward and forward citation chasing of included papers, and follow-up of identified trial/study protocols. We ran an updated database search in October 2023, and the results went through the same process of deduplication and screening as the original database search results.

One reviewer extracted data for each study into a bespoke Microsoft Excel extraction sheet, and a second reviewer independently verified the extracted data. We appraised the quality of all included papers using a tool appropriate to the epidemiological study design (i.e. randomised controlled trial (RCT), or surveillance study) used in each paper under review. We used Version 2 of the Cochrane risk-of-bias tool for cluster-randomised controlled trials (RoB 2 CRT) in order to assess the quality of one RCT, while the appropriate National Heart, Lung, and Blood Institute (NHLBI) tool was employed in order to assess the quality of included surveillance studies. We completed feasibility assessments for each outcome of interest in order to determine if any form of meta-analysis was appropriate. We evaluated the certainty of evidence for the main outcomes using the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) tool.

Findings

Fourteen of 10,687 screened studies were included in this review. Of the 14 included primary studies, 3 primary studies assess specific triage services and 11 primary studies assess general triage services. Seven of the 14 studies reported the mean age of participants, which ranged from 31 years to 68.9 years. The sex breakdown was reported in 13 primary studies and ranged from 42.8% to 100% female participants. Publication dates for the included studies ranged from 2017 to 2023. Meta-analyses were not appropriate. All findings were described narratively. Evidence for all outcomes was of very low certainty.

Specific triage services

Safety

Three studies assessed the safety of specific triage services. Safety outcomes measured included mortality (one study), hospital admissions (two studies), accuracy of triage compared with initial hospital or ED assessment (two studies), accuracy of triage compared with later clinical follow-up (one study), and intubations (one study).

One study, a cluster RCT, reported very low-certainty evidence indicating no significant difference in **mortality** related to hereditary angioedema attacks in the specific triage intervention group compared with the usual care group.

Two studies examined rates **of admission to hospital and intensive care units (ICUs)**, and both reported very low-certainty evidence. The first study, a cluster RCT, found statistically significantly lower hospital admissions for hereditary angioedema attacks over 2 years in the specific triage intervention group compared with the usual care group. The same study reported no significant difference in ICU admissions between study groups. The second study reported that no pregnant patients who were triaged to intermediate urgency were hospitalised with a life-threatening situation, compared with 0.8% of patients triaged to high urgency, indicating no undertriage of life-threatening situations.

Two surveillance system studies, both reporting very low-certainty evidence, assessed the **accuracy of remote triage compared with initial hospital or ED assessments**. The first study reported 53% agreement between specific triage urgency levels (intermediate and high urgency) and the urgency levels assigned at face-to-face hospital assessments for pregnant women, with a 16% undertriage rate. The second study reported a sensitivity of 80% (true positive cases), a specificity of 60% (true negative cases), and a positive predictive value of 71% for diagnosing myasthenia gravis exacerbations. However, 11% of calls were undertriaged, as patients who were advised to stay home presented to the ED with diagnosed exacerbations.

One surveillance system study reported very low-certainty evidence on the **accuracy of a specific regional telephone triage service for pregnant women compared with later clinical follow-up**. The study focused on calls referred to the hospital, excluding those triaged to self-care. After clinical assessment, urgent care was needed in 8% of all calls. Of these calls, the majority (77.5%) required a consultation only, with 77% of intermediate-urgency calls and 78% of high-urgency calls sent home after consultation.

One cluster RCT reported very low-certainty evidence on **intubation** rates in people with chronic hereditary angioedema. This study indicated no significant difference in intubation rates between the specific triage intervention and usual care groups of people with chronic hereditary angioedema over the 2-year study period.

Effectiveness

All three specific triage services studies assessed effectiveness. The effectiveness outcomes measured were triage disposition (three studies), ED attendance (one study), and overtriage (two studies).

All three studies (two surveillance system studies and one cluster RCT) reported very low-certainty evidence regarding **triage disposition outcomes** in specific triage services. The first study reported triage dispositions for pregnant callers as follows: high urgency (64% of calls) and intermediate urgency (36% of calls). Low-urgency calls were not recorded in this study. The second study reported triage dispositions for callers with myasthenia gravis as follows: attend the ED (62% of calls), and stay at home and monitor symptoms (38% of calls). The third study, a cluster RCT, reported no significant difference in patients with hereditary angioedema directed to monitor at home between the intervention and usual care groups.

One surveillance system study reported very low-certainty evidence on **ED attendance** in a specific triage service for callers with myasthenia gravis. This study reported that 73.3% of calls resulted in an ED presentation.

Two surveillance system studies reported very low-certainty evidence on **overtriage** rates in specific triage services. In the first study, which assessed calls from pregnant women, a 30% overtriage rate was reported among those triaged to high and intermediate urgency levels. All calls triaged as life-threatening emergencies received the same triage status at the hospital. In the second study, there was a 17.8% overtriage rate among callers with myasthenia gravis following remote triage compared with specialist in-person assessment in the ED. Among those who were directed to attend the ED, 29% did not have an exacerbation, resulting in a false positive rate of 40%.

General triage services

Safety

Eleven studies assessed the safety of general triage services. The safety outcomes measured were mortality (three studies), hospital admissions (five studies), and other indicators of undertriage (nine studies). Other indicators of undertriage included the accuracy of general triage services compared with face-to-face assessments; the accuracy of general triage services compared with the final diagnosis; the accuracy of general triage services based on serious adverse events; and the accuracy of general triage services based on a validated tool.

Three studies reported very low-certainty evidence on **mortality at either different time points or in different populations**. The first study reported a 7-day mortality rate of 0.02% among young adult callers with chest pain who were triaged to below the need for an ambulance or presentation to the ED. The second study reported a same-day mortality rate of 0.12%, a 7-day mortality rate of 0.8%, and a 30-day mortality rate of 1.5% among unique patients triaged to Level E (i.e. below the need for an ambulance). The third study reported a 30-day mortality rate of 0.2% for callers aged 36 years and over with chest pain who were triaged to below the need for ED attendance.

Five studies assessed **hospital admissions,** reporting very low certainty outcomes across all studies. The first study reported admission rates of 8.6%, 10.5%, and 12.0% within 1, 7, and 30 days, respectively, of general triage among patients triaged to Level E (i.e. below the need for an ambulance). The second study reported admission rates of 5.4%, 7.1%, and 9.1% within 1, 3, and 7 days, respectively, among calls triaged to below the need for an ambulance or taking alternate transport to the ED. The third study reported a significantly higher likelihood of calls triaged to ambulance or ED attendance levels being admitted to hospital compared with calls triaged to alternative service providers or self-care. Specifically, hospital admission rates within 2 days of using the general triage service were 6.5% among those triaged

to below the need for an ambulance or presentation to the ED (11.1% for those dispatched alternative service providers and 5.1% for those provided self-care advice). The fourth study reported that 4.2% of callers to the National Health Service (NHS) 111 line in the Yorkshire and Humber regions who were triaged to below the need for an ambulance or presentation to the ED were admitted to the hospital within 3 days of their call. Finally, the fifth study reported that 6.8% of young adult callers with chest pain who were triaged to below the need for an ambulance or presentation to the ED were admitted to hospital within 7 days of their call.

Nine studies assessed **other indicators of undertriage**, reporting very low certainty evidence across all studies. Five studies reported on the **accuracy of general triage services compared with face-to-face assessments** conducted by healthcare professionals following remote triage. The first study reported an undertriage rate of 1.6% (within 6 hours of the call) among calls triaged to below the need for an ambulance but advised to visit a hospital within 1 or 6 hours when compared with a face-to-face assessment completed by a doctor, meaning that 1.6% of callers were deemed to have needed an ambulance upon a home visit by a doctor. The second study, based on those who presented to the ED without a referral and who were judged to need care above the assigned triage disposition level, reported an undertriage rate of 8.7% within 1 day of the general triage call, 10.6% within 3 days of the call, and 13.1% within 7 days of the call. The third study reported an undertriage rate of 9.6% within 2 days of calling a general triage service based on callers who were assigned to low triage dispositions presenting to ED and not being classed as non-urgent. The fourth study reported an undertriage rate of 9.5% within 2 days of the general triage call compared with face-to-face assessment of severity in the ED. The fifth study, which specifically examined calls from young adults with chest pain, reported an undertriage rate of 2.4% within 7 days of the general triage call for calls triaged to below the need for an ambulance or presentation to the ED based on assessment in hospital determining a requirement for urgent treatment.

Under the '**other indicators of undertriage**' heading, two studies reported on the **accuracy of general triage services based on the final diagnosis.** In one study the overall sensitivity for appropriately triaging actual cases of transient ischaemic attack or stroke was 73.5%, with 26.5% of true cases being missed. The overall sensitivity for appropriately triaging actual cases of acute coronary artery syndrome in the second study was 78.5%, with 21.5% of true cases being missed.

One study reported on the **accuracy of initial triage disposition based on the subsequent occurrence of serious adverse events (death or organ support)** in callers with symptoms of coronavirus disease 2019 (COVID-19). This study reported on serious adverse events at 3-, 7-, and 30-day follow-up time points. Overall sensitivity at 30 days was 74.2%, with higher values at 7 days (74.4%) and 3 days (81.4%). Sensitivity increased to 77.3% when using triage assessments from final calls compared with first calls, and in phase 2 of the study (when loss of taste and smell were added as symptoms), sensitivity rose to 85.7%, although false positives also increased from 38.5% to 48.5%, meaning that higher numbers of callers were triaged to urgent care unnecessarily.

Finally, one study reported on the **accuracy of a general triage service based on a validated tool** based on two subgroups: high-risk calls (callers aged 30 years and over with abdominal pain), and a random sample of general calls. Using an item from the Assessment of Quality in Telephone Triage tool, a clinically relevant undertriage rate of 5.5% was reported in the random subgroup of general calls. In high-risk calls, a clinically relevant undertriage rate of 7.9% was reported.

Effectiveness

Ten of the 11 studies on general triage services assessed the effectiveness of these services. The effectiveness outcomes assessed were triage disposition (nine studies), ED attendance (four studies), overtriage rates (two studies), case resolution (one study), and healthcare utilisation (two studies).

Nine studies reported on **triage disposition**, reporting very low certainty evidence across all studies. The first study reported that most calls were triaged to an intermediate urgency level of a general practitioner (GP) home visit/primary care out-of-hours appointment within 1, 2, or 4 hours. This indicated an ED avoidance rate (i.e. the percentage of callers triaged to levels below ED attendance) of 82.7% among young adult callers with chest pain. The second study reported that most callers were triaged to below the need for an ambulance or for urgent follow-up COVID-19 clinical assessments (which could include advice to self-present to ED), indicating an ED avoidance rate of at least 61.8% among callers with COVID-19 symptoms. The third study reported that the majority of calls were directed to venues outside of the ED, indicating an ED avoidance rate of 87% among callers aged over 36 years with chest pain. Within this study, physician-directed calls gave ED referral advice to 10% of callers, whereas nurse-directed calls gave ED referral advice to 16% of callers.

The fourth study reporting on **triage disposition** only analysed low-acuity callers by design, triaging calls referred from the Australian emergency telephone number. This study reported that most of the callers were directed to attend the ED, either being advised to self-present to the ED (19.1%) or being returned to dispatch for an ambulance (47.6%), indicating a low ED avoidance rate of 30.5%. The fifth study also assessed only non-urgent cases by design. However, this study on unique patients reported that the majority of callers were triaged to non-ED levels, indicating an ED avoidance rate of 82.1%.

The sixth study assessing **triage disposition** reported an ED avoidance rate of 81.8% among general calls to the NHS 111 line. The seventh study reported an ED avoidance rate of 100%; however, the study population was limited to calls originally triaged to non-emergency care in emergency medical dispatch centres. The eighth study assessed callers with symptoms of transient ischaemic attack or stroke, most of whom were triaged to non-ED levels, indicating an ED avoidance rate of 70.3%. This study was based on a general triage service in the Netherlands in which the only triage disposition option for referral to ED was ambulance. The final study, based on data from the same service in the Netherlands, assessed calls with symptoms of acute coronary artery syndrome. Given the categorisations applied by the study authors, it was not possible to calculate an ED avoidance rate for this study. However, the authors reported that 63% of all calls were triaged to a high-urgency disposition (e.g. ambulance, or GP home visit or out-of-hours service in primary care (OHS-PC) appointment within 1 hour), while 37% were triaged to a lower-urgency disposition (e.g. GP home visit or OHS-PC appointment within 3 hours; OHS-PC appointment or telephone advice within 24 hours; or telephone advice only with no time frame specified).

Four studies reported on **ED attendance**, reporting very low certainty evidence across all studies. The first study, which only assessed non-urgent Level E patients (triaged to below the need for an ambulance) by design, reported ED attendance rates of 24.3% within 1 day of the triage call, 26.0% within 7 days of the triage call, and 27.7% within 30 days of the triage call. Similarly, the second study only analysed calls triaged to non-emergency care (below the need for an ambulance or presentation to the ED) by design, and it reported ED attendance rates of 16.2% within 1 day of the triage call, 19.2% within 3 days of the triage call, and 23.7% within 7 days of the triage call. The third study, assessing callers initially deemed low acuity and passed onto the referral triage service, reported that 41.3% of callers ended up presenting to ED within 2 days of their call. The fourth study reported on **ED attendance** among general callers to the NHS 111 general triage line. Within 2 days of the general triage call, 21.6% of all callers attended the ED.

Two studies investigated **overtriage rates**, reporting very low certainty evidence across all studies. The first study assessed overtriage rates at entry to a general triage service in both a random sample of general callers and a high-risk subgroup of callers (those aged 30 years and over with abdominal pain). Two triage models were compared in the high-risk group, and an overtriage rate of 2.4% was reported in the GP-led triage model, whereas an overtriage rate of 9.5% was reported in the nurse-led triage model. For the random sample of general calls, an overtriage rate of 6.7% was reported when both models were combined.

For the second study we calculated an **overtriage rate** for calls to a general triage service (NHS 111), by comparing calls triaged to a high urgency (either transferred to 999 for ambulance dispatch or advised to attend the ED) with follow-up status on ED presentation. Overall, 1.2% of all calls were overtriaged as 11.3% of those referred to the ED and 3.6% of those triaged to ambulance dispatch were deemed non-urgent upon presentation to the ED.

One study provided very low-certainty evidence on **case resolution** for young adults with chest pain within 1 day of calling the NHS 24 triage service. A case resolution rate of 89.4% was reported among calls triaged to self-care, which indicated an overall case resolution rate of 7.4% for all calls.

Two studies assessed follow-up **healthcare utilisation outcomes outside of ED attendance and admissions**, and both studies reported very low-certainty evidence. The first study tracked calls by young adults reporting chest pain from their initial NHS 24 triage disposition to their next unscheduled care service contact within 24 hours. The data suggested that the initial triage category of advice given to callers was the most likely service area in which these callers would appear again. The second study analysed data from non-urgent patients and tracked the healthcare utilisation of the study population within 1, 7, and 30 days of their initial call. Of these callers, 57.9% had no further contact with the healthcare system regarding acute conditions (within 1 day of the call) or with their GP (within 7 days of the call).

Conclusions

Given the array of between-study differences, with diverse specific subpopulations, triage disposition levels, outcomes, and follow-up periods examined, it was largely impossible in this review to comment on patterns across studies. Based on guidelines relating to acceptable target undertriage and overtriage levels we found very low-certainty and mixed evidence that remote general triage services are safe, as well as very low-certainty evidence that these services are effective. We also found very low-certainty evidence that specific remote triage services are safe and effective, but no reference standard for comparison was available for the specific conditions or symptoms covered in our included studies on specific triage services. Based on this review, we cannot say that remote triage services are not safe or effective, as the design and conduct of the included studies are not adequate to establish their safety and effectiveness with moderate or high certainty. Therefore, we need large, high-quality studies on complete general triage systems covering all triage dispositions, and the undertriage and overtriage outcomes need to be compared with established standards. Our specific findings cannot be directly compared with existing systematic reviews, although the existing reviews also reported uncertain and mixed findings.

1 Introduction

1.1 Policy context

Emergency department (ED) overcrowding is a prevalent global issue that significantly impacts on hospital operations. The consequences are far-reaching, affecting resource availability and compromising healthcare service delivery. In Ireland, ED attendance increased by 13.3% between 2012 and 2021 (

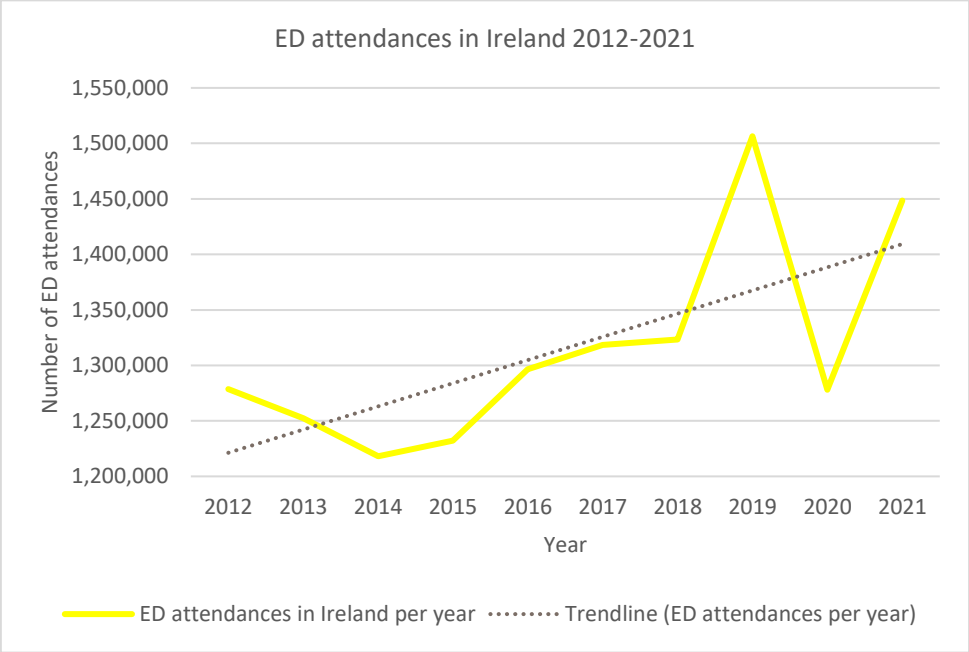

Figure 1). In 2021, just under 1.45 million ED attendances were recorded in Ireland [3].

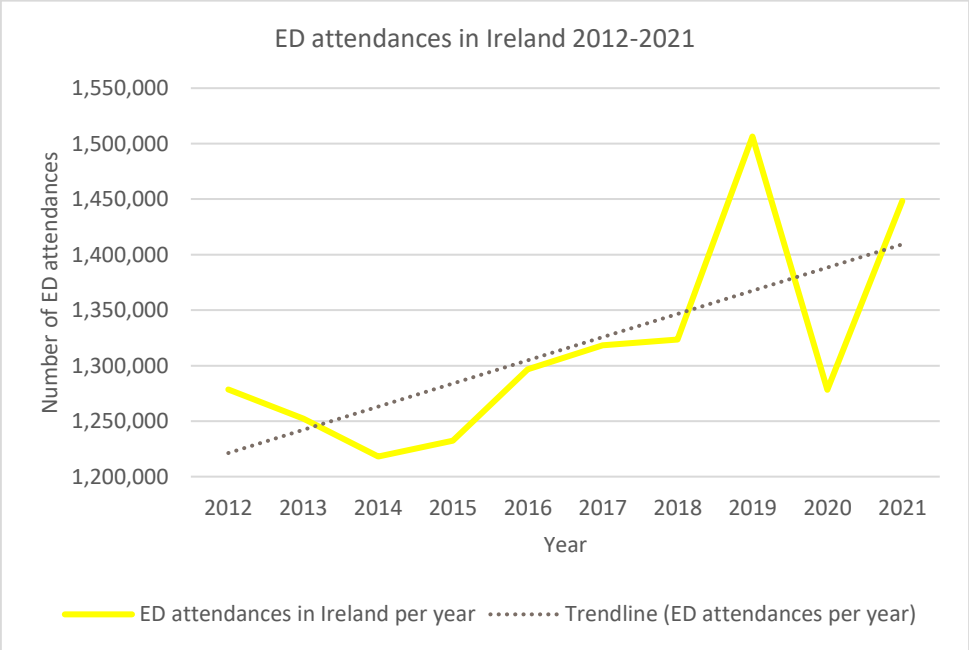

Figure 1 ED attendances in Ireland, 2012–2021

Data source: Health in Ireland key trends 2022 [3].

Currently pathways to ED in Ireland include calling emergency services on 999/112, being referred to ED by a GP or out of hours GP or self-presenting at ED without referral for which a charge of €100 is incurred

[4]. Remote pre-hospital triage strategies are currently being considered in order to reduce unnecessary ED attendance in Ireland and to fulfil Strategic Priorities 2 and 3 from the Department of Health's (DOH's) Statement of Strategy 2021-2023, which are to "Expand and integrate care in the community" and "Make access to healthcare fairer and faster" [5]. Pre-hospital triage is the sorting of undifferentiated patients into appropriate categories based on suspected pathology and how critically ill they are [6]. However, research synthesis on remote pre-hospital triage is limited [7] and further evidence relating to the safety and effectiveness of this practice is required in order to inform policy-making in Ireland.

A review on this topic is required in order to synthesise the existing evidence related to the safety and effectiveness of remote pre-hospital triage. This review will support the work of the Unscheduled Care Performance Management Board sub-group in identifying whole-system mitigations for ED overcrowding. The findings will be shared with the Health Service Executive in the context of the development of the 3-year Unscheduled Care Performance Improvement Plan.

1.2 Background

Accurate pre-hospital triage – the effective sorting of undifferentiated patients into appropriate categories based on suspected pathology and level of acuity or how critically ill they are – represents a critical task in pre-hospital emergency care [6].

The use of pre-hospital triage systems in order to manage demand for unscheduled health care is growing and now used in many developed countries [8]. Remote pre-hospital triage typically involves employing technology-based systems as a means to triage patients to the suitable level of care. This facilitates remote clinical decision-making without face-to-face encounters. The triage process occurs in real time utilising platforms such as the telephone, email, or video calls in order to overcome barriers to access. In the United Kingdom (UK), National Health Service (NHS) Direct, a national, nurse-led telephone helpline (now replaced by NHS 111), was first piloted regionally in 1998 [7]; other telephone triage systems that countries have implemented include NHS 24 in Scotland, primary out-of-hours care in Norway, and localised telephone triage systems in the United States of America (USA) [8]. Although less common, online tools have also emerged in recent years in the USA, the UK, and other European countries [7]. For example, England has implemented a national service in the form of the NHS 111 (formerly NHS direct) online tool [9].

A systematic approach to remote pre-hospital triage requires the use of a specific set of questions or a digital triage tool. A recent review on telephone-based triage defined digital triage as involving "a call handler or clinician using a digital triage tool to generate advice based on an assessment of a patient's symptoms", with advice typically taking "the form of signposting within defined levels of urgency to specific local services, such as an emergency department (ED), out of hours centre or general practice (GP) appointment" [10 p1]. The American College of Emergency Physicians, in noting the rapid increase in remote triage and telehealth technologies since the onset of the COVID-19 pandemic, has also called for a standard approach to triage in order to minimise risks to patient safety, with "a valid and reliable triage tool" [11 p450] required in order for providers to identify urgent/emergent patients who need escalation of care.

There is a lack of review evidence in relation to the safety of remote pre-hospital general triage. A 2019 review of primary studies was unable to draw strong conclusions due to a lack of studies [12]. More recently, a 2023 review of cohort studies that were conducted during the COVID-19 pandemic, which included studies on video calls and apps, found evidence indicating reduced unnecessary visits to EDs and improved clinical outcomes, such as reduced mortality and injuries [13].

In addition to general triage services, pre-hospital triage services for specific conditions have also been researched, although these are not always included in reviews of remote triage systems [12]. Conditions include acute coronary syndrome [14], acute respiratory disorders [15], suspected head and neck cancer, chronic kidney disease, diabetic foot complications, and COVID-19 [13]. Evaluations of condition-specific triage typically focus on the sensitivity and specificity of the triage system in accurately detecting the condition in question, as opposed to non-specific remote triage, where evaluation may focus on more general outcomes such as adverse events, delayed care, and patterns of service use [12]. Reviews relating to remote triage for acute coronary syndrome have indicated improved safety and accuracy outcomes, including lower mortality rates and quicker treatment times [16] and improved accuracy over current triage dispatch systems [14]. In relation to other conditions such as acute respiratory disorders, review evidence has indicated that remote triage via telephone, video, and online methods were all appropriate for detecting severe respiratory distress or need for emergency care [15].

A comprehensive, high-quality review including studies conducted before, during, and since the COVID-19 pandemic is currently needed in order to bring together evidence from the last few decades on the safety of remote triage for the triage of both general and specific conditions. An updated review is needed especially in light of the technological developments and growth in the use of remote triage since 2020 [17], with additional clarity needed in relation to the safety of remote triage based on clinical governance models, as reviews published to date report mixed findings when comparing triage conducted by various healthcare professionals [8,18]. In addition to patient safety outcomes, several reviews have examined the effectiveness of remote pre-hospital triage in appropriately reducing service use or healthcare utilisation, with mixed findings emerging. While some reviews indicated reductions in inappropriate healthcare utilisation [13], others reported inconsistent or limited evidence [7,10,19]. Organisational-level triage interventions may be more effective than national- or regional-level interventions, given that Rushton *et al.* found that local practice-based telephone triage had a higher rate of case resolution (based on triage disposition alone rather than actual healthcare utilisation) and was able to divert more patients away from emergency healthcare services than regional- or national-level telephone triage systems [12]. However, the extent of actual impacts on ED attendance and healthcare utilisation (as opposed to delays in attendance or utilisation) [12] remain unclear given that reviews often neglect to assess healthcare utilisation in the follow-up period [8,10,14–16,20–23], meaning that the true impacts of remote pre-hospital triage services on ED attendance are not clear.

These evidence gaps provide a strong rationale for the further investigation of remote pre-hospital triage as a potential method of safely dealing with the increasing demand for unscheduled healthcare. Our review will focus on any pre-hospital triage services conducted remotely and using modes including the telephone, online services, apps, Short Messaging Service (SMS), video calls, etc. Therefore, in this case, remote pre-hospital triage refers to pre-hospital triage which is not conducted in person in addition to not being conducted on-site at the ED, and therefore excludes any in-person triage at primary care services or injury clinics as well as field triage by paramedics. Triage services which employ a validated decision support tool (sometimes referred to as digital triage) will be included. Studies reporting on general triage and studies reporting on triage for specific conditions will be analysed separately in this review. A review on this topic will add to the currently limited literature on remote pre-hospital triage and support the work of the Unscheduled Care Performance Management Board sub-group in identifying whole-system mitigations for ED overcrowding.

1.3 Research question

The following research question was agreed in collaboration with the DOH:

- Are remote pre-hospital triage services safe for adults seeking unscheduled care, and where safe, are they effective in reducing ED attendance appropriately?

This research question was split into two sub-questions:

1. Are remote pre-hospital triage services safe for adults seeking unscheduled care?
2. In the case of remote pre-hospital triage services which appear to be safe, are these services effective in reducing ED attendances?

2 Methods

2.1 Review design

A systematic review was the preferred type of evidence synthesis for this research question, as the intention was to systematically gather and synthesise existing evidence in order to provide an up-to-date summary of the state of research knowledge on the intervention of interest.

The study protocol was registered and is available to view on PROSPERO, the international prospective register of systematic reviews (registration number: CRD42023432772) [24]. This systematic review is reported according to the Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) criteria [25] and the Synthesis Without Meta-analysis (SWiM) in systematic reviews reporting guideline [26]. Appendix Bpresents the completed checklists.

We have separated the included studies into two groups throughout this review:

1. Specific triage services, and
2. General triage services.

Specific triage services specialise in triaging for particular conditions or symptoms, such as stroke, obstetric concerns, or coronavirus disease 2019 (COVID-19). The primary aim of specific triage services is to accurately identify or rule out the specified condition, and specific triage can be targeted towards either the general population or specific subgroups. For example, a specific triage intervention might be established in order to identify individuals with suspected myocardial infarction based on a previous diagnosis of coronary heart disease, or to identify patients with suspected stroke in the general population.

In contrast, general triage services are not targeted towards identifying cases of a particular condition but are designed for use in both the general population and specific subgroups of patients in order to categorise patients based on how critically ill they are and therefore determine their need for emergency medical assistance regardless of the specific symptom or condition. General triage services also naturally collect data on specific symptoms and will activate specific protocols if particular symptoms are reported. Studies analysing general triage service data, can therefore also assess general triage within patient populations reporting particular symptoms such as all individuals using the triage service who reported chest pain as a primary symptom or complaint.

2.2 Eligibility criteria

The eligibility criteria for this review are outlined in Table 1, including population, intervention, comparison, and outcomes (PICO) inclusion and exclusion criteria.

Regarding population, the scope of this systematic review was limited to patients aged over 16 years, as in Ireland, clinical guidelines related to the Emergency Medicine Early Warning System apply to patients aged 16 years and over. Primary studies including a mix of patients (aged under and over 16 years) were excluded if patients aged under 16 years were reported to constitute more than 25% of the primary study sample and safety outcomes were not separable on age. The setting of interest was any Organisation for Economic Co-operation and Development (OECD) member country where remote pre-hospital triage services have been used.

Trials, before and after studies and surveillance system type studies were included while other cohort and cross-sectional studies were excluded. Surveillance system studies are a particular form of cohort study which meet key criteria and were therefore useful in answering our research question without

introducing severe self-selection bias. In the current review our definition of a surveillance system study was a study which included:

- All users of a triage service in a given period (or a subset as per predefined criteria), with no consent required at the point of intervention, and
- A valid comparator (i.e. linked follow-up clinical data or an assessment using a validated tool) which was either:
  - Available either for the entire population or for entire triage disposition categories, or
  - Based on observed presentations for the entire population in included hospital(s) in a given time frame, with no presentation presumed to indicate safe pre-hospital triage.

In relation to the outcomes of interest, in line with our research question, studies had to include at least one safety outcome in order to be eligible. Studies published from January 1998 onward were eligible. The year 1998 was selected based on the earliest study result included in previous systematic reviews on this topic [18,19]. Primary research published after this date was also expected to be more relevant to modern triage techniques.

Table 1 Eligibility criteria

Domain	Inclusion	Exclusion
Population	• Patients aged 16* years and over • Patients in OECD member countries using any remote pre-hospital triage service during the study period • Patients in OECD member countries for whom caregivers used any remote pre-hospital triage service during the study period on the patient's behalf • Mock patients (assessed using a valid too*)	• Patients aged under 16 years • Inpatient populations and populations in residential facilities that provide regular medical care
Intervention	• Pre-hospital patient- or caregiver-operated remote triage services provided remotely (via telephone, online tools, apps, SMS, or video call) including out-of-hours phone lines for initial assessment and management of unscheduled care focused on a clinical care issue (recommending treatment and/or providing appropriate referrals and employing a validated decision support tool (or the clinical judgement of a medical doctor*) for general or specific conditions operated by any staff and/or technology and within OECD member countries • Note: Multilevel triage will be regarded as primary triage where triage takes place within one service but is escalated as needed (e.g. a caller to a triage line speaks to a non-medical call handler in the first instance, followed by a nurse as required, and followed by a medical doctor as required).	• In-hospital triage (including on-site remote or e-triage, such as kiosks) • Information-only services • Any in-person triage (field triage by ambulance/helicopter; general practitioner (GP)/out-of-hours in-person triage) • Triage done as part of a scheduled healthcare visit • Secondary triage • Telemonitoring, health coaching, counselling, or longitudinal care management • Urgent mental health crisis line • Communications beyond initial transfer of information from a patient-initiated contact • Triage that is not clearly remote
Comparison	• Usual care • No triage service	

Domain	Inclusion	Exclusion
	• Active control (e.g. telephone line offering advice or information only with no referrals) • For surveillance system studies, no comparison group was required as triage disposition levels, provided an indication of the accuracy of triage levels and undertriage and overtriage rates in relation to outcomes such as mortality, admissions and later clinical assessments*	
Outcomes	**Direct (primary outcomes)** • Safety (missed major events; major trauma; mortality; long-term morbidity; undertriage; required admission/re-presentation; delayed diagnosis) • Effectiveness (ED attendance (adjusted and unadjusted); triage disposition*; overtriage rate; case resolution, i.e. proportion of calls resolved without referral; healthcare utilisation in follow-up period)	• Healthcare professional-perceived safety/accuracy • Patient-perceived safety/accuracy
Study design	• Randomised controlled trials • Non-randomised controlled trials • Before and after studies • Population-based surveillance system studies • (We only allowed studies defining themselves as cohort and cross-sectional studies where these met our definition of a surveillance system study as described above)	• Cohort studies* • Case-control studies* • Case studies • Cross-sectional studies • Ecological studies • Qualitative studies • Reviews (systematic and non-systematic) • Overviews of reviews (systematic and non-systematic) • Letters • Editorials • Conference presentations
Date	• 1998 to present, but the search included the year 1997 in case any 1998 papers were not dated correctly	• Before 1998

*Deviations from original protocol

2.3 Identifying research evidence

2.3.1 Approach to searching

The approach we used in the literature searches for this review was to prioritise sensitivity (capturing as much relevant material on the topic of emergency remote triage as possible, at the cost of including irrelevant results) over specificity (capturing primarily relevant material, at the cost of excluding some relevant research). Although we aimed to maximise search sensitivity, it was important to maintain the time frame allotted for this review project, so searches and search iterations could not be unlimited.

While no formal definition of a comprehensive search has been agreed in the available guidance [27], it was expected that a comprehensive approach to the searches could be achieved through the use of a range of clinical, allied health, and social care databases; registries; and preprint repositories and other grey literature sources, and through the use of citation searching, reference list checking, and the follow-up of protocols and conference abstracts or posters.

2.3.2 Literature search concepts

In order to reflect the research questions, the primary concept of the search was 'triage'. This was supplemented by the concepts 'emergency' and 'remote' (Figure 2).

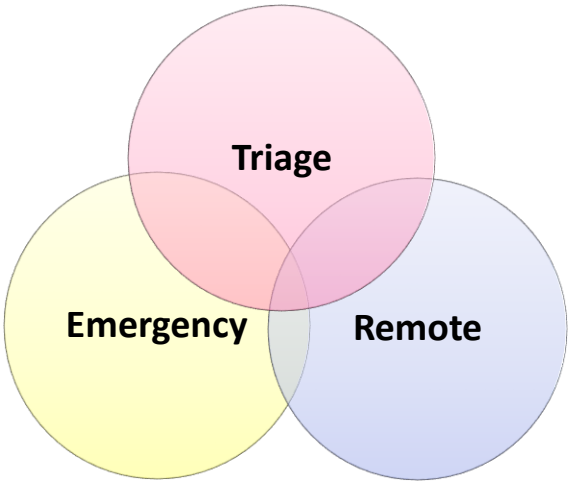

Figure 2 Literature search concepts

2.3.3 Information sources

The information specialist searched a range of 19 databases, registries, repositories, and other search resources in order to capture relevant information in the primary and supplemental searches for this review. These included six clinical and social research databases: the Cochrane Database of Systematic Reviews/Cochrane Central Register of Controlled Trials, EBSCO CINAHL, EBSCO MEDLINE, EBSCO SocINDEX with Full Text, Embase (via Embase.com), and APA PsycInfo (via Ovid). Databases that we used with a strong focus on non-English-language research included Latin American and Caribbean Health Sciences Literature (LILACS) and SciELO. They searched the database Epistemonikos (which includes broad syntheses, primary studies, structured summaries, and systematic reviews), as well as the International Health Technology Assessment (HTA) database. They searched the grey literature database OpenGrey via the Data Archiving and Networked Services (DANS) interface. Repositories and registries searched included Lenus, the Irish health research repository; the preprint repositories OSF.io, medRxiv/bioRxiv, and Research Square; and the trials registry ClinicalTrials.gov. We also examined BASE: Bielefeld Academic Search Engine, DuckDuckGo.com, and Google Scholar search engines.

The information sources for the review also included the reference and citation lists of papers selected for inclusion after the full-text screening stage, as well as relevant protocols and conference posters identified during the screening process.

The primary search resources were the Cochrane Library (the Cochrane Database of Systematic Reviews/Cochrane Central Register of Controlled Trials), EBSCO MEDLINE, EBSCO CINAHL, EBSCO SocINDEX with Full Text, Embase (via Embase.com), the international HTA database, Lenus, LILACS (via VHL portal), medRxiv/bioRxiv, OpenGrey (via DANS), OSF.io, APA PsycInfo (via Ovid), and Research Square. Resources for the supplemental searches included ClinicalTrials.gov, DuckDuckGo.com, Google Scholar, EBSCO MEDLINE, and SciELO. Reference and citation searching was based on the included papers from the primary searches, and protocol searching was based on protocol and conference abstracts identified in the primary searches.

2.3.4 Search terminology

The terminology for the search was based around the main concepts of 'emergency', 'remote', and 'triage'. In order to search for these concepts, we carried out scoping searches to examine the terminology typically used with these concepts. Terminology was extracted from relevant research and tested.

The search was designed within the EBSCO MEDLINE database using controlled vocabulary (Medical Subject Heading (MeSH) terms) and keywords. PubReMiner, the online PubMed text-mining tool, was used in order to source MeSH terms and keywords commonly used in the literature with these concepts [28]. We also used the standalone MeSH Browser [29] and consulted MeSH terms and keywords of known relevant papers.

2.3.5 The terminology relating to the concept 'triage' encompassed terms that included the term 'triage' itself (such as 'undertriage', 'overtriage', or 'triageur'), as well as related terms such as 'e-referral', 'pre-assessment', 'patient prioritisation', and 'emergency screening'. Relevant MeSH terms included 'Triage', 'Referral and Consultation', 'Decision Support Systems, Clinical', and 'Answering Services'. Terms relating to the concept 'remote' included the MeSH terms 'Remote consultation', 'Telemedicine', 'Telephone', and 'Mobile Applications', and included keywords such as 'e-health', 'email', 'apps', 'computer-assisted', 'Internet', and many others. The terminology relating to the concept 'emergency' included keywords such as 'pre-hospital', 'after-hours', 'out-of-hours', 'emergency care', 'pre-emergency', and 'time-critical'. The MeSH term 'Emergency Medical Service Communication Systems' was used. After testing, it was found that using broader 'emergency' MeSH terms returned very large numbers of irrelevant results without adding to the numbers of relevant results, so for this concept, the use of "title/abstract"-level searches for relevant keywords was found to be more useful after testing. Full details of all search terms are provided in Appendix BSearch limiters/filters

The information specialist employed a date limit in these searches, in order to keep the results in line with the PICO requirements (Table 1). For well-structured databases where a date limit/filter could be useful/accurate and complex searches were possible (such as EBSCO MEDLINE, EBSCO CINAHL, EBSCO SocINDEX with Full Text, Embase (via Embase.com), and APA PsycInfo via Ovid), a date limit of 1997–2023 was used. This meant that our searches should capture any papers that had been published from 1998 to 2023 and indexed appropriately, as well as preprints of those papers.

For resources in which the data were not structured so that a date limit could be useful (such as search engines where dates retrieved may not always reflect actual publication dates), where complex searching was not possible (for example, where single-line searches were used, such as OpenGrey), or where the database contents were expected to be recent (for example, trial registries and preprint servers such as OSF.io and Research Square), no date limit was used and earlier records from these resources were removed in line with the review's PICO criteria through the formal screening process.

The information specialist did not use any study design or country limits for the searches; instead, we applied these eligibility criteria during the screening process (Section 2.4). We did not employ any formal language limit, and while we used a number of databases which focus on non-English-language research, there is a known English-language bias when using databases which focus predominantly on English-language research. The results of our primary and supplemental searches were predominantly in the English language.

2.3.6 Supplemental searching

Supplemental searches carried out in October 2023 comprised forward and backward citation-chasing (or reference and citation searching); follow-up of relevant protocols, conference abstracts, and conference posters identified in the screening process from the primary searches; searches of additional research resources; and a follow-up search of EBSCO MEDLINE.

The information specialist used Dimensions, the linked research data platform, to extract the reference lists of journal articles as .ris files where possible [30]. These were checked against the published reference lists, and missing references were added to the extracted records. We manually extracted the reference lists for theses or reports from the PDF documents. These lists were formatted using AnyStyle.io and converted to BibTeX files. The information specialist extracted the citations for each record from Dimensions where possible, and extracted additional citations from Google Scholar. For records not in Dimensions, Google Scholar was the primary source for citations.

For following up on protocol lists, the information specialist used EBSCO MEDLINE, Google Scholar, and ClinicalTrials.gov in order to verify details such as study names, author names, trial registration/protocol numbers, and any other available details.

We conducted a follow-up search in EBSCO MEDLINE to capture any relevant studies indexed in this database since the primary searches had been carried out in June 2023. We also carried out searches in the trials registry ClinicalTrials.gov, the search engines DuckDuckGo.com and Google Scholar, and the databases Epistemonikos and SciELO. Details of all searches are available in Appendix B.

2.3.7 Search dates

The information specialist researched the primary searches in the first week of June 2023, and ran the searches and recorded them in the various databases on 9, 10, and 11 June 2023. We carried out the supplemental searches, comprising searches in additional search resources and follow-up searches in EBSCO MEDLINE (see Section 2.3.6), in October 2023.

2.3.8 Search data management

The information specialist deduplicated the search results from the primary searches in EndNote X9 and imported the deduplicated citations into EPPI-Reviewer Web for screening [31]. At the full-text stage of screening, we uploaded the PDFs of the citations to be screened to the relevant records in EPPI-Reviewer Web.

We employed EPPI-Reviewer Web's Priority Screening machine-learning system in order to screen citations at the title and abstract stage, given the large number of citations to screen (n=10,687). We employed standard screening of citations in Comparison/Normal mode (non-Priority Screening) at later stages of screening. All uploaded records and screening verdicts are held in EPPI-Reviewer Web.

2.4 Screening of search results

We carried out screening of the literature search results using a multistage screening process. We employed blinded comparison screening (where two researchers independently screened each paper and compared their verdicts) at the title and abstract and the full-text screening stages. Single screening of results was carried out at the title and abstract screening of supplemental search results, followed by comparison screening at the full-text stage. The stages of the screening process were numbered within EPPI-Reviewer Web for clarity and ease of management. The screening stages were numbered as:

- Stage 1a: title and abstract screening of primary search results
- Stage 1b: deduplication of Stage 1a results
- Stages 2: full-text screening of primary search results
- Stage 2b: re-evaluation of items from stage 2a coded 'exclude on study design'
- Stage 2c: final screening results including records from stage 2b
- Stage 3: data-extraction screening of primary search results
- Stage 4: title and abstract screening of secondary search results
- Stage 5: full-text screening of secondary search results
- Stage 6: data-extraction screening of secondary search results

2.4.1 Screening on title and abstract

The information specialist carried out deduplication of the primary search results prior to the title and abstract screening stage. Of the initial 14,676 results obtained from the primary information searches, we removed 3,989 duplicates, leaving 10,687 results to be screened by the review team in screening stage 1a. Screening commenced on 13 June 2023.

Four members of the review team (AB, JF, CL, NMG) carried out title and abstract screening in EPPI-Reviewer Web. We used comparison screening in order to reduce bias in the screening process, whereby each record was independently screened by two screeners. The verdicts given by the two screeners for each record were then compared and reconciled at regular reconciliation meetings. The specific reconciliation mode used at this stage in EPPI-Reviewer Web was "Reconciliation mode: Multiple: auto complete (include/exclude level)". In this mode, where the two verdicts given to a record in double screening were both 'exclude' codes of any kind (for example, one screener records an 'exclude on study design' code and the other records an 'exclude on intervention' code for a record), the record was then coded by EPPI-Reviewer as an exclusion. Where a record was coded by one screener as an 'include', and by the second screener as an 'exclude' of any kind, this difference required 'reconciliation' within EPPI-Reviewer Web by the screeners.

Based on the review's PICO criteria, the codes used to screen records at stage 1a of the title and abstract screening were:

- Include on title and abstract
- Exclude on intervention
- Exclude on study design
- Exclude on date
- Exclude on age
- Exclude on outcomes

- Exclude on country
- Exclude on target group, and
- Exclude on relevant protocol/conference abstract/poster/systematic review.

In addition to the PICO-based codes, an additional code was added in order to capture study protocols, reviews, and conference abstracts and posters, with a view to following up on these results in the supplemental searches. Due to time constraints, it was not possible to follow up on the records of reviews captured (see Section 2.3.6). An 'exclude on duplicate' code was not used at this stage of comparison/double screening, as it can be difficult to accurately distinguish duplicates where the records are divided between a group of four when using EPPI-Reviewer Web's Priority Screening tool.

We used the Priority Screening tool for title and abstract screening. This is a machine learning tool in EPPI-Reviewer Web which is trained to recognise the type of record that is relevant to the user based on information in the titles and abstracts of the records, such as study design, intervention, or age. The system presents the records it has selected as more likely to be relevant to the screeners, so that those records that are more likely to be relevant can be screened earlier in the process and coded as 'includes'. At a point in the screening process where no further records that can be coded as 'includes' are detected, a plateau appears in the graph of records. At that point, it is considered safe to switch to normal/single screening of records.

For this review, a plateau spanning more than 1,000 records can be seen in the screenshot of the EPPI-Reviewer Web Priority Screening graph, representing the records screened as of 26 July 2023 (Figure 3). On 25 July, 287 records had been coded as 'includes' from 6,709 records screened. On 26 July 2023, of 7,715 records screened, no further 'includes' were noted, and it was deemed safe to switch to normal/single screening, where each record only received one verdict and the likelihood of finding many further records that were relevant to the review was considered low. This approach speeds up the screening process. All four screeners continued to screen the remaining records, but from that point, each record received one verdict and reconciliation between multiple screeners was not required.

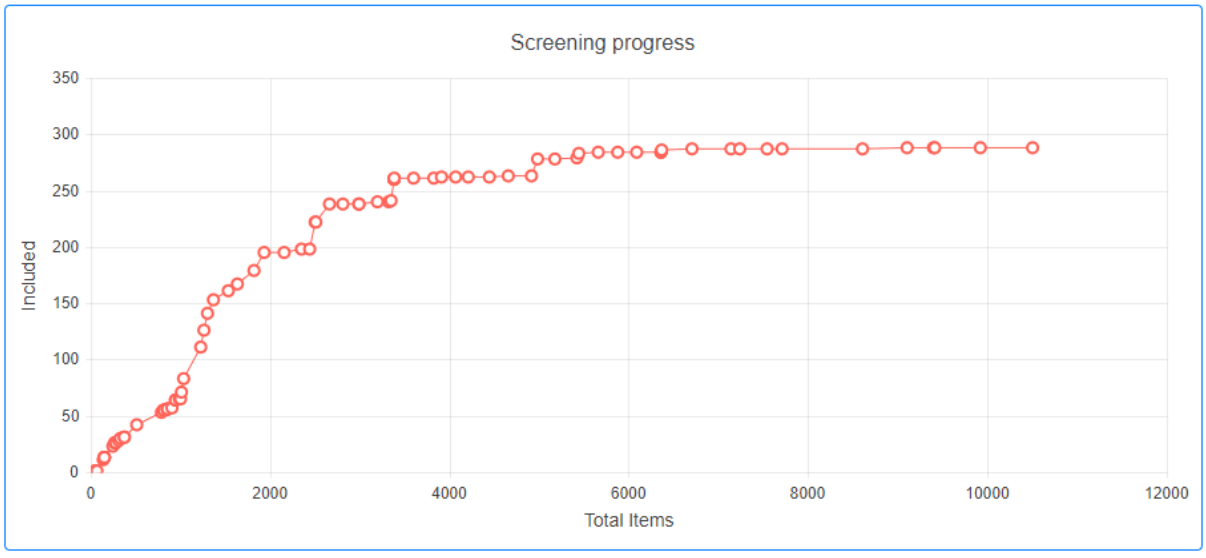

Figure 3 Screenshot of screening records on the safety and effectiveness of remote pre-hospital triage for appropriate ED attendances and service use

At the end of stage 1a of title and abstract screening, 288 records were included for screening at stage 1b. These records were entered into a further stage of screening in order to exclude duplicates. This stage was carried out by normal/single screening by one screener (CL). After stage 1b, 282 records were

available for full-text screening. The complete articles relating to these records were sourced by the information specialist (CL). Of the 282 records, 278 full-text records were sourced; the remaining 4 records could not be sourced.

2.4.2 Screening on full text

In screening stage 2a, we carried out full-text screening on the 282 records that were included from the title and abstract screening process. This was done by standard comparison/double screening, rather than by using the Priority Screening tool. The set of records to be coded at the full-text stage included the 4 records for which the full texts could not be sourced, and a screening code to capture this description was included. The codes used for this stage of screening, based on the review's PICO criteria, were:

- Include on full text
- Exclude on intervention
- Exclude on study design
- Exclude on date
- Exclude on age
- Exclude on outcomes
- Exclude on country
- Exclude on target group
- Exclude on study design (trial protocol, conference abstract or poster, systematic review), and
- Exclude on unable to source.

However, after discussion, it was determined that the team needed to re-evaluate the items excluded on study design during stage 2a of the screening process. These 42 screened records were separated into a subgroup (stage 2b) and re-screened with the following codes:

- Include on full text
- Exclude on study design
- Exclude on intervention, and
- Exclude on outcomes.

The remainder of the records included in Stage 2a were screened as normal. The information specialist formally recorded the results from Stages 2a and 2b in EPPI-Reviewer Web as stage 2c of full-text screening. Details of all full text exclusions are provided in Appendix C.

2.4.3 Screening of supplemental search records

We screened the 4,653 records sourced from supplemental searches (see Section 2.3.6) in EndNote X9 in order to remove duplicates. Of these records, 946 were considered to be duplicates. The information specialist (CL) uploaded the remaining 3,707 records to EPPI-Reviewer Web for title and abstract screening. The information specialist carried out title and abstract screening as a normal/single screening. The codes used for this screening stage (recorded as stage 4 of screening in EPPI-Reviewer Web and on the PRISMA flow chart) were:

- Include on title and abstract

- Exclude on intervention
- Exclude on study design
- Exclude on outcomes
- Exclude on target group
- Exclude on date
- Exclude on age
- Exclude on country
- Exclude: already screened from primary searches
- Exclude on duplicate
- Exclude on study design (trial protocol, conference abstract or poster, systematic review), and
- Exclude on unable to source.

Records which occurred in this screening stage which had also previously occurred in the primary searches and had been screened by the team in a previous iteration were coded as 'exclude: already screened from primary searches'.

After screening on title and abstract, 169 records were included for full-text screening. The information specialist sourced the PDFs of the papers for these 169 records and uploaded them to EPPI-Reviewer Web. Two researchers (AB and JF) comparison/double-screened the records as Stage 5 of the screening process using the following codes:

- Include on full text
- Exclude on intervention
- Exclude on study design
- Exclude on outcomes
- Exclude on target group
- Exclude on date
- Exclude on age
- Exclude on country
- Exclude: already screened from primary searches
- Exclude on duplicate
- Exclude on study design (trial protocol, conference abstract or poster, systematic review), and
- Exclude on unable to source.

Of those 169 records from supplemental search result screening, 9 were included.

2.4.4 Screening during data extraction

While not a formal screening process, due to the close reading and analysis possible in the data extraction process, records which had been included for data extraction underwent de facto screening and a number of records were found to be ineligible for inclusion in the review. These records were

excluded after formal discussion between three researchers (AB, JF, ÁT). We then recorded the verdicts in EPPI-Reviewer Web (as Stage 3 for primary search results and Stage 6 for supplemental search results) under the following codes:

- Include for synthesis
- Exclude on outcomes
- Exclude on intervention
- Exclude on study design: no validated tool (mock patients)
- Exclude on study design: self-selection
- Exclude on study design: secondary triage
- Exclude on study design: not system surveillance
- Exclude on age, and
- Exclude on duplicate.

After all screening processes, the final number of studies eligible for inclusion in the review was 14: 9 studies were from the primary search results and 5 studies were from the supplemental search results.

2.5 Data extraction

One reviewer extracted data for each study into a bespoke extraction sheet in Microsoft Excel. We used the Template for Intervention Description and Replication (TIDieR) checklist to structure the data extraction form in order to ensure a comprehensive description of the key intervention characteristics of interest (Table 2 TIDieR checklist) [32]. Extracted data were verified independently by a second reviewer against a clean copy of the publication or abstract.

The data extraction forms included information on the following: author; year published; study aim; study design; study data collection method; participants; setting; duration of observations; time of year the data were captured (and any information on chronological trends for effectiveness outcomes); remote pre-hospital triage characteristics; comparators; safety outcomes evaluated and their findings; effectiveness outcomes evaluated and their findings; statistical or sensitivity tests; and confounding and statistical interactions.

Following the extraction of main study data, we extracted specific outcomes and confounders into bespoke extraction sheets for safety and effectiveness outcomes. For each outcome, data were extracted by one reviewer before later being independently verified by a second reviewer.

Table 2 TIDieR checklist

Question number	Short name	Full question
1	Brief name or description	Provide the name or a phrase that describes the intervention.
2	Why or rationale	Describe any rationale, theory, or goal of the elements essential to the intervention.
3	What or material content	Describe any physical or informational materials used in the intervention, including those provided to participants or used in intervention delivery or in training of intervention providers.
4	What or procedural content	Describe each of the procedures, activities, and/or processes used in the intervention, including any enabling or support activities.
5	Who or person delivering it	Describe the composition of the multidisciplinary team.
6	How or mode of delivery	Describe the modes of delivery of the intervention (such as face to face or by some other mechanism, such as Internet or telephone) and whether it was provided individually or in a group.
7	Where or place of delivery	Describe the type(s) of location(s) where the intervention was delivered, including any necessary infrastructure or other relevant features.
8	When and how much	Describe the number of times the intervention was delivered, and over what time period, frequency of sessions, schedule of sessions, duration of sessions, and intensity of sessions.
9	Modifications	If the intervention was modified during the study, describe the changes (what, why, when, and how).
10	Adapting or tailoring	If the intervention was planned to be personalised, titrated, or adapted, then describe what, why, when, and how.
11	Fidelity or adherence	If intervention adherence or fidelity was assessed, describe how and by whom, and describe strategies that were used to maintain or improve fidelity.
12	Actual fidelity	If intervention adherence or fidelity was assessed, describe the extent to which the intervention was delivered as defined.

Source: Hoffmann *et al.* 2014 [32]

2.6 Quality assessment

Given the heterogeneity in the design of eligible studies, we used two quality appraisal tools in order to assess the quality and risk of bias of each of the included studies. In order to minimise systematic and non-systematic errors, two reviewers independently assessed the quality of all included studies, with any disagreements resolved by consensus. This consisted of both reviewers later meeting to discuss where an

item had indeed been rated differently for any included study and coming to a consensus rating for these through discussion. Quality assessment and risk of bias ratings were not used to exclude studies from the analysis, but were used to describe the main strengths and limitations of the studies.

2.6.1 Randomised controlled trials

Version 2 of the Cochrane risk-of-bias tool for cluster-randomised trials (RoB 2 CRT) was used in order to quality assess cluster-randomised controlled trials (RCTs) [33]. The RoB 2 CRT instrument assesses risk of bias across five domains: trial design (randomisation and recruitment), deviations from the intended intervention, outcome ascertainment, missing outcome data, and selective reporting. Within each domain, a series of questions (termed 'signalling questions') aim to elicit information about features of the RCT that are relevant to risk of bias. A proposed judgement about the risk of bias arising from each domain is generated by an algorithm based on answers to the signalling questions. Judgement can be 'low risk of bias', can express 'some concerns', or can be 'high risk of bias'. Domain and overall scores are presented in Appendix D

2.6.2 Surveillance system studies

The National Heart, Lung, and Blood Institute (NHLBI) has developed a 14-item quality assessment tool for observational cohort and cross-sectional studies; we used an adapted version of this tool to assess surveillance system studies, as these would be similar to observational studies (such as cohort studies or cross-sectional surveys) [34]. In adapting this tool, we split items 4 and 5 into two parts so that each component of these items could be addressed (Table 3 Overall quality rating calculation for surveillance system studies). Item and total scores are presented in full in Appendix E.

Public health surveillance is the ongoing, systematic collection, analysis, and interpretation of health-related data essential to the planning, implementation, and evaluation of public health practice [2]. A surveillance system study employs surveillance data in order to answer a research question.

For the purposes of this review, as also described above in Section 2.2, the Health Research Board (HRB) defined a surveillance system study as one which included:

- All users of a triage service in a given period (or a subset as per predefined criteria), with no consent required at the point of intervention, and
- A valid comparator (i.e. linked follow-up clinical data or an assessment using a validated tool) which was either:
  - Available either for the entire population or for entire triage disposition categories, or
  - Based on observed presentations for the entire population in included hospital(s) in a given time frame, with no presentation presumed to indicate safe pre-hospital triage.

Surveillance system studies could be based on audits and single-site studies once our defined criteria were met.

For each study, we calculated an overall quality rating using a bespoke scoring system, based on the criteria that were most important for observational studies (in this case, surveillance system studies) [35]. We selected five items from the NHLBI's quality assessment tool and scored them as outlined in Table 3; two items had two criteria each, giving a total of seven criteria. These items pertained to unrepresentative sampling, lack of power or variance reported, inconsistent or poorly defined outcomes, loss to follow-up, and confounding.

For each study, we summed the NHLBI scores for the five selected items (for a total score ranging from 0.0 to 5.0). Studies scoring less than 3.0 were rated 'low quality', studies scoring 3.0 were rated 'moderate quality', and studies scoring 3.5 or more were rated 'high quality'. Where study authors did not report or only partially reported information related to each item, we awarded zero points or a partial point. For studies where loss to follow-up was not known or not reported, we awarded zero points in relation to item 13, "Was loss to follow-up after baseline 20% or less?".

Table 3 Overall quality rating calculation for surveillance system studies

Item	Scoring
4A. Were all the subjects selected or recruited from the same or similar populations (including the same time period)?	Yes: 0.5 No: 0.0
4B. Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes: 0.5 No: 0.0
5A. Was a sample size justification, power description, and expected effect estimates provided?	Yes: 0.5 Partial yes: 0.25 No: 0.0
5B. Was a description of variance provided?	Yes: 0.5 No: 0.0 N/A: 0.5
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes: 1.0 Partial yes: 0.5 No: 0.0
13. Was loss to follow-up after baseline 20% or less?	Yes: 1.0 No: 0.0 Not reported: 0.0
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	Yes: 1.0 No: 0.0

N/A = not applicable

2.7 Synthesis

2.7.1 Descriptive characteristics of included studies

As described in Section 2.5, we used a bespoke extraction sheet incorporating study characteristics, PICO criteria, and TIDieR checklist domains in order to extract descriptive characteristic data from each included study. Data extraction for each study was carried out by one reviewer and validated by another. Descriptive data from the included studies were documented in the table of characteristics (provided in Appendix F).

2.7.2 Outcome categorisation

We initially extracted data related to the outcomes of interest in each included study using the bespoke extraction sheets described in Section 2.5. We extracted all outcome data under two headings: specific condition triage services and general triage services, as per Section 2.1. Under each heading, we categorised data under safety and/or effectiveness outcomes (Figure 4).

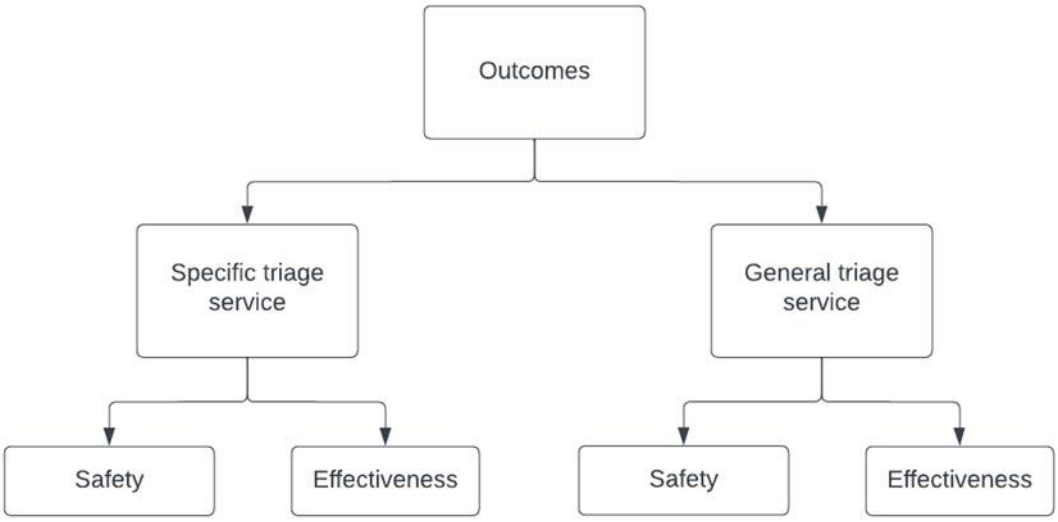

Figure 4 Outcome categorisation

We then identified sub-outcome measures under the safety and effectiveness categories, and this information will be provided in more detail in Section 3.

2.7.3 Feasibility assessment for meta-analysis

For each outcome of interest, we completed an assessment of the feasibility of meta-analysis following published guidance. Studies were grouped first by triage type and then by outcome. Following this, for each group of studies, comparability was assessed considering:

- Number of studies
- Study design
- Study quality or risk of bias
- Populations (based on inspection of inclusion criteria and baseline participant characteristics)
- Intervention, and
- Outcome measures (based on definition and methods of measurement).

The approach to meta-analysis for each outcome was guided by the *Cochrane Handbook for Systematic Reviews of Interventions* [36]. We intended to complete any meta-analyses using RevMan V5.4. However, the feasibility assessment indicated that it was not appropriate to proceed with meta-analysis; details of the feasibility assessment are reported in Appendix G.

2.7.4 Narrative synthesis

Where meta-analysis was not possible, we followed the steps for narrative synthesis as set out in the *Cochrane Handbook for Systematic Reviews of Interventions* [36]. Narrative synthesis employs a

descriptive text-based approach for the outcome(s) of each intervention that considers the relationships within and between studies, provides a summary of overall findings, and gives an assessment of the robustness of the evidence. We undertook a narrative synthesis of the included studies, as the results of the meta-analytic feasibility assessment indicated that there were too few studies or the study characteristics were too diverse (either clinically or methodologically) to combine in a meta-analysis. All numeric results were presented to one decimal place where data were available and to zero decimal places where the data did not allow. Summary tables detailing the outcome, study population, triage levels included, quality assessment or risk of bias, study design and certainty of evidence were provided.

Originally, where conducting narrative synthesis, we had also intended to identify patterns in the results across outcomes. Where studies reported the same outcome at the same follow-up period, we examined other sources of heterogeneity across studies such as staff conducting triage, organisational level of triage service and particular patient populations involved and where possible commented on patterns across studies. However, given the high risk of bias, low comparability between outcomes, and diversity of patient populations, it was not possible to identify meaningful patterns between the studies for the majority of the outcomes of interest.

2.7.5 Certainty of the evidence

We employed the Grading of Recommendations, Assessment, Development and Evaluations (GRADE) system in order to grade the certainty of the evidence and the strength of the recommendations for the outcomes by intervention [37]. While the quality assessment process described in Section 0 rates the quality of the design and conduct of individual studies, the GRADE approach is used in order to rate the quality of evidence for each outcome by intervention across the studies. Ultimately, a body of evidence related to an outcome (by intervention} receives one of four grades: high, moderate, low, or very low (Table 4).

Table 4 GRADE categories

GRADE category	Definition	Number of downgrades
High	We are very confident that the true effect lies close to that of the estimate of the effect.	0–1
Moderate	We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different.	2–4
Low	Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.	4–6
Very low	We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of the effect.	≥7

Source: Schünemann *et al.* 2013 [37]

Under the GRADE system, the initial certainty of the evidence is determined based on study design, with RCTs providing a high degree of certainty and observational studies providing a low degree of certainty [37]. The GRADE handbook does not provide specific guidance on the degree of certainty associated with surveillance system studies (the majority of studies included in this review). In this review, surveillance system studies collected data from the entire population of interest in a primary study (i.e. entire cohorts of all callers to a triage service in a given period (or a subset of all callers based on predefined criteria) with no consent required at the point of intervention). Although surveillance system studies can technically be defined as observational studies, they are not subject to the same sampling and

randomisation biases as other observational studies. Subsequently, based on discussion among the research team, it was decided that surveillance system studies could provide a moderate degree of certainty of evidence for each outcome, provided there was no evidence of bias, inconsistency, imprecision, or indirectness. The level of certainty is adjusted upwards or downwards based on a number of factors.

Each study can be downgraded based on five criteria:

1. Risk of bias, which takes account of study design considering the hierarchy of evidence and the methodological quality of the study (0, 1, or 2 downgrades); this included control for confounding and outcome measurement for surveillance system studies
2. Inconsistency, which considers both clinical and statistical heterogeneity that cannot be controlled for in the analysis (0, 1, or 2 downgrades)
3. Indirectness, which considers the comparator intervention and whether it is the current gold standard or it is being used as a proxy; indirectness also considers the population, intervention, and outcome (0, 1, or 2 downgrades)
4. Imprecision, which takes account of the size of the variance and the optimal effect size and is closely related to sample size and the number of events of interest (0 or 1 downgrades), and
5. Publication bias, which is a systematic underestimation or overestimation of the underlying beneficial or harmful effect due to the selective publication of studies (0 or 1 downgrades).

The decision to upgrade should only rarely be made if no serious limitations are present in any of these areas and should only be made after full consideration – and in the context – of reasons to downgrade. The reasons for upgrading are:

1. Large or very large estimates of the magnitude of an intervention or exposure effect (0 or 1 upgrades)
2. The presence of a dose–response gradient, which may increase confidence in the findings of observational studies (0 or 1 upgrades), and
3. Where all plausible residual confounding from observational studies may be working to increase or decrease the demonstrated effect, if no effect was observed (0 or 1 upgrades).

The GRADE handbook does not provide specific guidance on parameters for scoring the certainty of outcomes in the high, moderate, low, or very low categories (i.e. how many downgrades correspond with each category). In order to ensure objectivity and transparency, the research team set parameters for scoring each category (Table 4). A full account of scoring outcomes using GRADE is provided in Appendix H.

2.8 Deviations from the protocol

Originally, the protocol specified a population of patients aged 18 years and over in order for a study to be included in this systematic review. However, in Ireland, national clinical guidelines related to the Emergency Medicine Early Warning System apply to patients aged 16 years and over [38]. Based on these current national guidelines, we changed the population of interest for this systematic review to patients aged 16 years and over.

Additionally, once the research team began full-text screening, several studies included mixed adult and paediatric populations. In some cases, it was not possible to separate the sample by age, and a course of action in these situations had not been specified in the study protocol. Subsequently, we decided that if we could discern that 75% or more of a study sample was aged 16 years and over (based on the primary

study or a linked paper), the study would be included in this systematic review. Studies where more than 25% of the study sample were known to be aged 16 and under could also be included, provided an eligible safety outcome was separable based on age.

Following the publication of the protocol but before the commencement of title and abstract screening, the research team decided that cohort and case-control study designs should be excluded. This decision was informed by extensive discussions among the research team and was ultimately justified by the need to synthesise higher-quality research in order to inform policy-makers in this area. However, we have included a number of studies that defined themselves as cohort studies and one cross-sectional study, as they met the HRB's definition of a surveillance system study (as described in Sections 2.2 and 2.6.2).

In our protocol, we did not intend to include studies that did not have a comparator, but due to the paucity of evidence, we retained outcomes reported by triage disposition level, as they inform on accuracy of triage, although strictly speaking they had no comparator.

In our protocol we also listed outcomes as direct or indirect, but we did not retain this distinction in the review as the study designs ultimately included made this distinction less meaningful.

In our protocol we originally listed proportion directed to ED as an effectiveness outcome but in practice we extracted and reported on all triage dispositions where available, for instance also reporting proportions directed to visit their GP and self-care (see Section 3.7.2.2.1) as this is also useful information. This updated outcome is reflected in Section 2.2.

The protocol did not specify whether a validated tool would be required in studies involving mock patients. In order to avoid introducing unnecessary bias into the body of evidence, it was decided that a validated measurement tool would be required in order for studies involving mock patients to be included in this systematic review.

In relation to quality assessment using the NHLBI tool, critical domains were not specified in the protocol. Critical domains most relevant to surveillance system type studies were instead identified [35] as we classified particular observational studies as such (as described in Section 2.6.2).

3 Findings

3.1 Search results

Initial searches of databases and registers identified 14,676 records, of which 3,989 were duplicates, leaving 10,687 records for title and abstract screening. During title and abstract screening, we excluded 10,405 records, leaving 282 records for full-text screening. We excluded a total of 246 records at the full-text screening stage and 27 at the data extraction stage, leaving 9 records for extraction. We identified an additional 5 articles for extraction through supplemental searches, resulting in a final search yield of 14 reviews. The list of included studies is presented in Appendix I.

Figure 5 outlines the flow of information throughout the searching and screening process. All studies excluded at the full-text screening stage, with their reason(s) for exclusion, are presented in Appendix C.

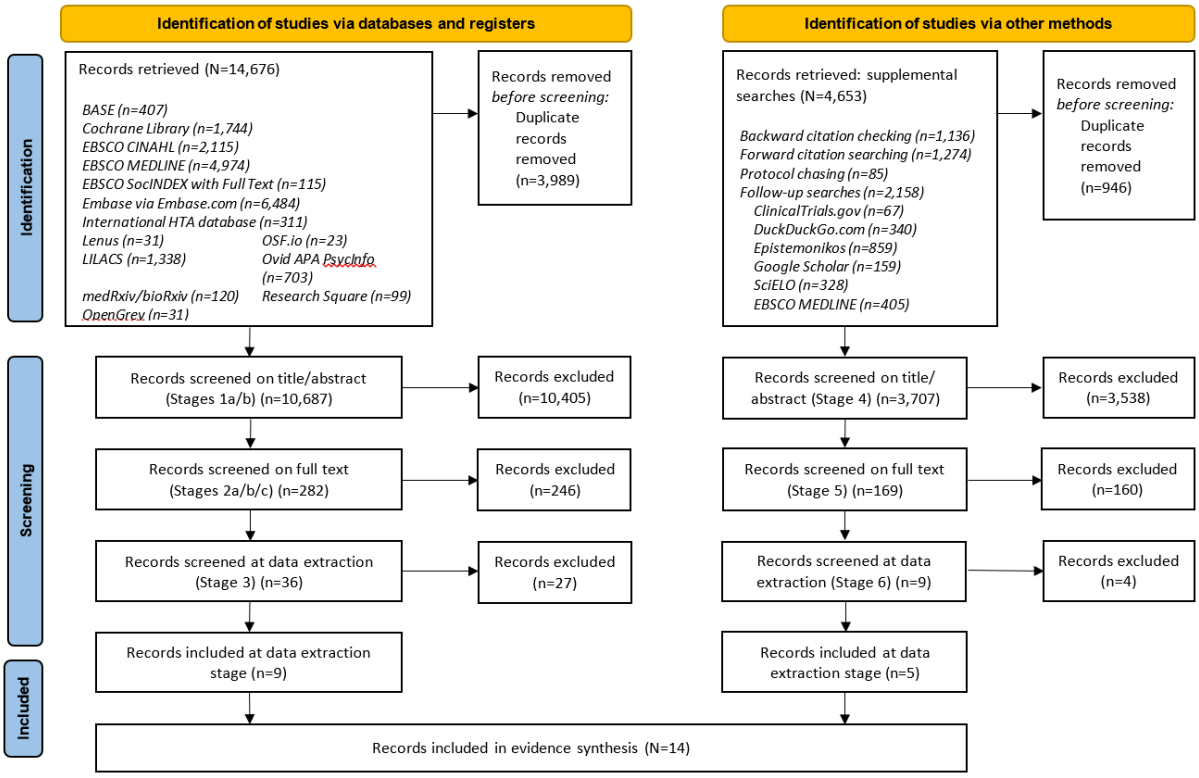

Figure 5 PRISMA flow diagram

Source: Page *et al.* 2021 [25]

3.2 Classification of primary study papers

The findings presented in this chapter are organised under two headings: specific triage services and general triage services. Under both headings, findings are organised by safety and effectiveness outcomes (Figure 4). Of the 14 included primary studies, 3 primary studies assess specific triage services [39–41]. The remaining 11 primary studies assess general triage services [42–52].

Of the 11 studies assessing general triage services, 1 study assessed safety and effectiveness in all callers regardless of symptoms or triage disposition [52], 5 studies focused only on a specific subpopulation or specific symptom rather than examining safety and effectiveness in all callers [42–46], and 1 study examined triage both in a random sample of general callers and in a specific subgroup [47]. The remaining four studies on general triage services focused on calls triaged to particular levels, including

less serious [48], Level E [49], non-emergency triage dispositions [50], and serious but below the need for ambulance dispatch with advice to attend hospital within 1 or 6 hours [51]. A description of these studies is provided in the table of characteristics in Appendix F, and a table detailing the triage services included in the studies is provided in Appendix J.

3.3 Synthesis of extracted data

The results of the meta-analysis feasibility assessment are provided in Appendix G and indicated that meta-analysis was not possible for any of the outcomes of interest. Once individual outcomes were separated by follow-up period, the included studies were too few or their characteristics too diverse, meaning that no meta-analysis was possible. It was also largely impossible to draw any subgroup comparisons across studies as planned in relation to clinical governance model, technology used, organisational level of triage service and specific patient populations. Where studies did examine the same outcome at the same follow-up period and differed on only one or two key aspects (such as staff doing triage, organisational level) comparisons were commented on with caution.

3.4 Characteristics of included primary studies

A full account of the characteristics of each included study is provided in Appendix I. Nine primary studies provided an overall mean or median age [39–41,43,45,46,48–51], three provided a breakdown of age groups by percentages only [42,44,47]. Two studies did not provide any details on age range for the whole sample [48,52]. Lewis *et al.* did not provide any details on age range for the whole sample beyond specifying that all calls were from adults aged 16 and over [52]. Eastwood *et al.* was deemed to have an age-appropriate sample for inclusion based on a cited article on the service [53] indicating at least 75% of callers are adults aged 16 and over (based on the interquartile range), and provided median ages by triage disposition for those presenting at ED only [48]. For the seven studies that reported a mean age, this ranged from 31 years to 68.9 years. The sex breakdown across the 13 primary studies reporting same, ranged from 42.8% to 100% female participants. Publication dates for the included studies ranged from 2017 to 2023.

In relation to study design, 13 primary studies were classified as surveillance system studies and 1 study was a cluster RCT. The included primary studies were based in a range of locations, including the Netherlands (three studies), the United Kingdom (UK) (three studies), Denmark (two studies), the United States of America (USA) (two studies), Australia (one study), France (one study), Japan (one study), and Sweden (one study). In relation to funding, two studies were funded by industry, eight studies were not funded by industry, and four studies did not report their funding sources. Full study characteristics are reported in Appendix F.

Of the 14 included studies, 3 studies assessed the safety and effectiveness of specific triage services (Table 5) [39–41].

Table 5 Safety and effectiveness outcomes of specific triage services

Outcome	Sub-outcomes	Study
Safety	Mortality	Javaud *et al.* (2018) [40]
	Hospital admissions	Javaud *et al.* (2018) [40] Engeltjes *et al.* (2021) [39]
	Other indicators of undertriage	Javaud *et al.* (2018) [40] Engeltjes *et al.* (2021) [39] Kukulka *et al.* (2020) [41]
Effectiveness	ED attendance	Kukulka *et al.* (2020) [41]
	Triage disposition	Javaud *et al.* (2018) [40] Engeltjes *et al.* (2021) [39] Kukulka *et al.* (2020) [41]
	Overtriage	Engeltjes *et al.* (2021) [39] Kukulka *et al.* (2020) [41]

Of the 14 included studies, 11 studies assessed safety in general triage services [42–52] and 10 provided effectiveness outcomes of general triage services (Table 6) [42–50,52].

Table 6 Safety and effectiveness outcomes of general triage services

Outcome	Sub-outcomes	Study
Safety	Mortality	Hodgins *et al.* (2022) [42] Lehm *et al.* (2017) [49] Sax *et al.* (2018) [44]
	Hospital admissions	Hodgins *et al.* (2022) [42] Eastwood *et al.* (2017) [48] Lehm *et al.* (2017) [49] Lewis *et al.* (2021) [52] Spangler *et al.* (2020) [50]
	Other indicators of undertriage	Hodgins *et al.* (2022) [42] Inokuchi *et al.* (2022) [51] Marincowitz *et al.* (2022) [43] Eastwood *et al.* (2017) [48] Lewis *et al.* (2021) [52] Spangler *et al.* (2020) [50] Engelen (2023) [45] Leclair (2023) [46] Graversen *et al.* (2023) [47]
Effectiveness	Triage disposition	Hodgins *et al.* (2022) [42] Marincowitz *et al.* (2022) [43] Sax *et al.* (2018) [44] Eastwood *et al.* (2017) [48] Lehm *et al.* (2017) [49] Lewis *et al.* (2021) [52] Spangler *et al.* (2020) [50] Engelen (2023) [45] Leclair (2023) [46]
	ED attendance	Eastwood *et al.* (2017) [48] Lehm *et al.* (2017) [49] Lewis *et al.* (2021) [52] Spangler *et al.* (2020) [50]
	Overtriage	Lewis *et al.* (2021) [52] Graversen *et al.* (2023) [47]
	Case resolution	Hodgins *et al.* (2022) [42]
	Healthcare utilisation	Hodgins *et al.* (2022) [42] Lehm *et al.* (2017) [49]

3.5 Methodological quality of included studies

3.5.1 Cluster RCT

We used the RoB 2 tool to quality assess the one included cluster RCT. The RoB 2 tool assesses risk of bias across five domains: trial design (randomisation and recruitment), deviations from the intended intervention, outcome ascertainment, missing outcome data, and selective reporting. The methodological quality of the included cluster RCT was rated as having a low risk of bias. A full account of the RoB 2 assessment for the cluster RCT is provided in Appendix D.

3.5.2 Surveillance system studies

We used the NHLBI quality assessment tool for observational cohort and cross-sectional studies to assess the 13 included surveillance system studies [34]. This 14-item tool is designed to assess both cohort and cross-sectional studies but can be applied to surveillance system studies according to our definition of these studies.

For each surveillance system study, we calculated an overall quality rating using a bespoke scoring system, based on the criteria that were most important for surveillance system studies in this context. These items pertained to unrepresentative sampling, lack of power or variance reported, inconsistent or poorly defined outcomes, loss to follow-up, and confounding.

The methodological quality of the included surveillance system studies was varied. Eleven studies were rated as having high methodological quality; one study was rated as having moderate methodological quality; and one study was rated as having low methodological quality. A full account of the NHLBI assessments for each study is provided in Appendix E.

3.6 GRADE rating

The calculated GRADE scores included downgrades for inadequate conduct of the primary study, specifically in relation to risk of bias, inconsistency of the results (heterogeneity), indirectness of the evidence, imprecision, and publication bias. High-quality studies reported zero or one downgrade, moderate-quality studies reported two to four downgrades, low-quality studies had four to six downgrades, and very low-quality studies had seven or more downgrades. The GRADE score is used as a summary indicator of the quality or certainty of the evidence that is presented. The GRADE certainty of evidence for the primary outcomes is presented in Section 3.7, and the number of and reason for downgrades are presented in Appendix H.

Under the specific triage services heading, all safety and effectiveness outcomes were of very low certainty. Under the general triage services heading, all safety and effectiveness outcomes were also of very low certainty.

3.7 Results

3.7.1 Specific triage services

3.7.1.1 Safety

Three studies assessed the safety of specific triage services (Table 5) [39–41]. The safety outcomes measured were mortality (one study), hospital admissions (two studies), and other indicators of undertriage (three studies).

3.7.1.1.1 Mortality

One cluster RCT study (comprising 200 patients) reported on mortality outcomes in specific triage services (a national-level triage telephone line) compared with usual care (no changes made to usual practice treatment, and patients were not given the national-level triage telephone line number) for people with chronic hereditary angioedema [40].

This study reported very low-certainty evidence indicating no significant difference in mortality or death rates related to hereditary angioedema attacks in the intervention group compared with the usual care group [40]. In the 2-year follow-up period, no deaths related to hereditary angioedema attacks were reported in either the intervention group or the usual care group. Of note, two deaths were reported in the intervention group, but these were not related to hereditary angioedema disease: one was due to breast cancer at the 12-month follow-up time point and the other was due to leukaemia at the 14-month follow-up time point. Sensitivity analysis accounting for loss to follow-up was conducted, and this analysis also indicated no significant difference between the intervention and usual care groups [40]. A summary of the evidence on mortality is presented in Table 7.

Table 7 Summary of evidence on mortality outcomes in a specific triage service

Outcome	Triage levels	Population	Study design	Risk of bias	GRADE certainty of evidence	Mortality rate (%)
Mortality due to hereditary angiodema Javaud *et al.* (2018) [40]	Not reported	People with chronic hereditary angioedema (n=200)	Cluster RCT	Low	Very low	Intervention: 0% Usual care: 0%

3.7.1.1.2 Hospital admissions

Two studies reported very low-certainty evidence on rates of admission to hospital or to intensive care units (ICUs) [39,40]. The results of the two studies cannot be pooled due to different study designs and populations. A summary of the evidence on hospital admissions is presented in Table 8.

The first study, a cluster RCT (comprising 200 patients), reported on admissions to hospital for a specific triage service (a national-level telephone triage line) compared with usual care for people with chronic hereditary angioedema [40]. This study reported very low-certainty evidence indicating a significantly lower likelihood of hospital admission for hereditary angioedema attacks in the intervention group compared with the usual care group (risk difference (RD): −0.13; 95% confidence interval (CI): −0.22 to −0.04; p=0.02). Over the 2-year follow-up period, the intervention group reported a mean of 0.03 admissions (range: 0–1) per patient compared with 0.16 admissions for hereditary angioedema attacks (range: 0–2) per patient in the usual care group. This cluster RCT also reported very low-certainty evidence indicating no significant difference in ICU admissions in the intervention group (specific triage service) compared with usual care (RD: 0.00; 95% CI: −0.04 to 0.04; p≥0.05). Over the 2-year follow-up period, both the intervention and usual care groups had a mean of 0.02 ICU admissions (range: 0–1) per patient. Sensitivity analyses accounting for loss to follow-up were conducted for rates of admission to hospital or to ICU; these analyses also indicated no significant differences between the intervention and usual care groups for both outcomes [40].

The second study, a surveillance system study (comprising 983 calls), reported on admission outcomes in a specific triage service (a regional-level telephone triage line) for pregnant women across four hospitals in the Netherlands [39]. This study reported very low-certainty evidence in relation to admissions to hospital. The Dutch obstetric telephone triage system consists of five urgency levels: resuscitation and

life-threatening (U1), emergency (U2), urgent (U3), non-urgent (U4), and self-care advice (U5). In this study, callers who were triaged to self-care (U5) were excluded by the authors, as these patients were not referred to hospital by the triage service. The remaining callers were grouped as high urgency (U1 or U2) and intermediate urgency (U3 or U4) for follow-up; the follow-up data on hospital admissions were missing for 12 U1–U4 calls. The duration of follow-up was not reported and no confounders, including hospital site, were adjusted for with respect to hospital admissions. No patients who were triaged to intermediate urgency (n=0 out of 352 calls) were hospitalised with a life-threatening situation compared with 0.8% of patients who were triaged to high urgency (n=5 out of 619 calls), indicating no apparent undertriage of life-threatening situations.

Beyond life-threatening situations an additional 73 of the 971 callers required hospitalisation, as they needed treatment or were in early labour, representing 8.8% of those triaged to intermediate urgency (n=31 out of 352 callers) and 6.8% of those triaged to high urgency (n=42 out of 619 callers) [39].

Table 8 Summary of evidence on rates of admission to hospital or to ICU in specific triage services

Outcome	Triage levels	Population	Study design	Risk of bias/NHLBI quality assessment	GRADE certainty of evidence	Admissions rate (%/M)
Hospital admissions for angiodema attacks Javaud *et al.* (2018) [40]	Not reported	People with chronic hereditary angioedema (n=200)	Cluster RCT	Low	Very low	Significantly lower likelihood in intervention compared with usual care *p*=0.02 Mean per patient over 2 years: Intervention: 0.03 Usual care: 0.16
ICU admissions Javaud *et al.* (2018) [40]	Not reported	People with chronic hereditary angioedema (n=200)	Cluster RCT	Low	Very low	No significant difference *p*≥0.05 Mean per patient over 2 years: Intervention: 0.02 Usual care: 0.02
Hospital admissions Engeltjes *et al.* (2021) [39]	• High: U1 (resuscitation and life-threatening) and U2 (emergency) • Intermediate: U3 (urgent) and U4 (non-urgent)	Pregnant women (n=983 calls)	Surveillance system	Moderate	Very low	Hospitalised with life-threatening situation: High: 0.8% Intermediate: 0% Hospitalised with treatment or early labour: High: 6.8% Intermediate: 8.8%

3.7.1.1.3 Other indicators of undertriage

3.7.1.1.3.1 Accuracy: Remote triage assessment compared with initial hospital or emergency department assessment

Two surveillance system studies reported very low-certainty evidence on the accuracy of remote triage assessments compared with initial hospital or emergency department (ED) assessments [39,41]. A summary of the evidence on accuracy compared with initial hospital or ED assessment is presented in Table 9.

The first study (n=983 calls) reported very low-certainty evidence on the accuracy of a specific triage service (a regional-level telephone triage line) compared with initial follow-up hospital assessment for pregnant women across four hospitals in the Netherlands [39]. Engeltjes *et al.* examined accuracy in calls referred to the hospital and excluded those triaged to self-care. This study reported that the pre-hospital triage levels of intermediate and high urgency had 53.4% (95% CI: 50–57%; n=525 out of 983 calls) agreement with the urgency level assigned at face-to-face hospital assessments. Undertriage occurred in 16.3% of the calls (n=160 out of 983 calls). The degree of undertriage compared with initial face-to-face hospital assessment was one category less severe (i.e. the call was graded less urgent by one triage category) in 84.4% (n=135) of the undertriaged calls, and was two or more categories less severe (i.e. the call was graded less urgent by two or more triage categories) in 15.6% (n=25) of the undertriaged calls [39].

Overall, the sensitivity (true positive probability) and specificity (true negative probability) for calls triaged to high urgency were reported as 76% (95% CI: 72–80%) and 49% (95% CI: 44–53%), respectively, with a positive predictive value (PPV) or probability that a person with a positive test result was a true positive of 60% (95% CI: 56–63%) and a negative predictive value (NPV) or probability that a person with a negative test result was a true negative of 67% (95% CI: 62–72%) [39]. The data were adjusted for hospital site but not for any other confounders, and while sensitivity between the four individual hospitals varied from 63% to 77%, analysis did not reveal any significant differences in accuracy based on hospital site. The overall weighted rates for the four hospitals combined were as follows: sensitivity: 75% (95% CI: 69–80%); specificity: 50% (95% CI: 46–53%); PPV: 59% (95% CI: 56–62%); and NPV: 67% (95% CI: 63–71%) [39].

The second study (N=25 patients with myasthenia gravis; n=45 calls) reported very low-certainty evidence on the accuracy of a specific triage service (using a single-breath count test administered by nurses over the telephone to screen for exacerbations of myasthenia gravis) compared with initial follow-up assessment at ED [41]. Follow-up ED assessments consisted of a diagnosis by a neurologist for those who presented to the ED. During the 1-year study period, 45 calls were made by 25 unique patients, and those scoring 25 or under on the single-breath count test were advised to go to the ED while those scoring over 25 were advised to stay at home and continue monitoring symptoms. In total, 28 of the 45 calls scored 25 or under and received advice to attend the ED; and ultimately 5 more calls scoring more than 25 resulted in an ED attendance that was deemed by a neurologist to be an exacerbation. Overall, pre-hospital triage had a sensitivity of 80% (95% CI: 64–96%) in diagnosing a myasthenia gravis exacerbation, a specificity of 60% (95% CI: 39–81%), and a PPV of 71%. Overall, 11.1% of all calls (5 out of 45) were undertriaged, as the patients were advised to stay home but presented to ED and did have a neurologist-diagnosed exacerbation [41]. There was no adjustment for confounders.

Table 9 Summary of evidence on the accuracy of triage assessment in specific triage services compared with initial hospital or ED assessment

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Accuracy rates (%)
Accuracy based on hospital assessment Engeltjes *et al.* (2021) [39]	• High: U1 (resuscitation and life threatening) and U2 (emergency) • Intermediate: U3 (urgent) and U4 (non-urgent)	Pregnant women (n=983 calls)	Surveillance system	Moderate	Very low	53.4% agreement 16.3% of calls undertriaged <u>High urgency:</u> Sensitivity: 76% Specificity: 49% PPV: 60% NPV: 67%
Accuracy based on ED assessment Kukulka *et al.* (2020) [41]	• Go to ED • Stay at home and monitor symptoms	People with myasthenia gravis (n=45 calls)	Surveillance system	High	Very low	11.1% of calls undertriaged Sensitivity: 80% Specificity: 60% PPV: 71%

3.7.1.1.3.2 Accuracy: Remote triage assessment compared with subsequent clinical follow-up in hospital

One surveillance system study reported very low-certainty evidence on the accuracy of a specific triage service (a regional-level telephone triage line) compared with later clinical follow-up for pregnant women (N=983 calls) in four hospitals [39]. Engeltjes *et al*. examined accuracy in calls referred to the hospital only (excluding those triaged to self-care)[39]. A summary of the evidence on accuracy compared with subsequent clinical follow-up in hospital is presented in Table 10.

This surveillance system study defined urgent care as hospitalisation with a life-threatening situation or hospitalisation with treatment, or the patient going into labour before 37 weeks' gestation [39]. Non-urgent care was defined as hospitalisation without treatment, or the patient going into labour at 37 weeks' gestation or later, or the patient being discharged home after consultation. The breakdown of these figures with respect to type of admission to hospital is reported in Section 3.7.1.1.2. This study reported that after clinical assessment, urgent care was needed in 8.0% of all calls (n=78 out of 971 calls), in 8.8% of calls triaged to intermediate urgency (n=31 out of 352 calls), and in 7.6% of calls triaged to high urgency (n=47 out of 619 calls), with five cases being life-threatening (as reported in Section 3.7.1.1.2). For most calls referred to the hospital, only a hospital-based professional consultation was required (77.5%; n=753 out of 971 calls), with 76.7% of intermediate-urgency calls (n=270 out of 352 calls) and 78.0% of high-urgency calls (n=483 out of 619 calls) sent home after a consultation. There was no adjustment for confounders, including hospital site, and the follow-up period was not reported. Follow-up data were missing for 12 calls [39].

Table 10 Summary of evidence on the accuracy of remote triage assessment in a specific triage service compared with subsequent clinical follow-up in hospital

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Rate of urgent care (%)
Accuracy based on later clinical follow-up Engeltjes *et al.* (2021) [39]	• High: U1 (resuscitation and life-threatening) and U2 (emergency) • Intermediate: U3 (urgent) and U4 (non-urgent)	Pregnant women (n=983 calls)	Surveillance system	Moderate	Very low	Overall: 8.0% Triaged to high urgency: 7.6% Triaged to intermediate urgency: 8.8%

3.7.1.1.3.3 Intubations

One cluster RCT (comprising 200 patients) reported on the number of intubations in the intervention group compared with the usual care group in people with chronic hereditary angioedema (Table 11 Summary of evidence on intubations in those with chronic hereditary angioedema in a specific triage serviceTable 11) [40]. Intubation is a process where a healthcare provider inserts a tube through a person's mouth or nose, then down into their trachea (airway/windpipe), in order to help the person breathe. Intubations are a potential indicator of undertriage, in those with hereditary angioedema, given that early intervention during a hereditary angioedema attack can play a crucial role in preventing the need for intubation. There was very low-certainty evidence indicating no significant difference in the number of intubations in the intervention group compared with the usual care group over the 2-year study period [40]. As no intubations were reported in either group, no inferential statistics were reported.

Table 11 Summary of evidence on intubations in those with chronic hereditary angioedema in a specific triage service compared with usual care

Outcome	Triage levels	Population	Study design	Risk of bias	GRADE certainty of evidence	Intubations rate (%)
Intubations Javaud *et al.* 2018) [40]	Not reported	People with chronic hereditary angioedema (n=200)	Cluster RCT	Low	Very low	Intervention: 0% Usual care: 0%

3.7.1.2 Effectiveness

Three studies assessed the effectiveness of specific triage services (Table 5) [39–41]. The effectiveness outcomes measured were triage disposition (three studies), ED attendance (one study), and overtriage (two studies).

3.7.1.2.1 Triage disposition

Three studies reported very low-certainty evidence on triage disposition outcomes in specific triage services in different study populations [39–41]. Generally, triage dispositions range from high urgency (e.g. ambulance or self-present to ED), down to moderate urgency (e.g. a primary care out-of-hours appointment), and finally down to low urgency (e.g. self-care, attend a general practitioner (GP), or make a scheduled primary care appointment). However, triage dispositions vary by triage service used and by country. A summary of the evidence on triage disposition is presented in Table 12. It was not possible to draw comparisons or report the range of rates at which callers were directed to attend the ED between these three studies given the unique study designs, study populations, and triage dispositions included.

The first study, a surveillance system study (comprising 983 calls from pregnant women), reported on triage disposition outcomes for a specific triage service (a regional-level telephone triage line) for pregnant women across four hospitals in the Netherlands [39]. The service includes five urgency levels (described in Section 3.7.1.1.2): resuscitation and life-threatening) (U1), emergency (U2), urgent (U3), non-urgent (U4), and self-care advice (U5). The authors reported the triage disposition of the calls as follows: 3 calls were classified as U1 (0.3%), 622 calls were classified as U2 (63.3%), 285 calls were classified as U3 (29.0%), and 73 calls were classified as U4 (7.4%). The authors did not report on patients triaged to U5. Among the four dispositions included, calls were most frequently triaged to emergency level (U2). Overall, when the dispositions were categorised into high (U1 and U2) and intermediate (U3 and U4) urgency, 63.6% of calls were categorised as high urgency and 36.4% of calls were categorised as intermediate urgency [39]. There was no adjustment for confounders and the certainty of the evidence was very low.

The second study, a surveillance system study (comprising 45 calls from 25 patients with myasthenia gravis), reported on triage disposition outcomes for a specific triage service administering a single-breath count test over the telephone [41]. The service includes two triage dispositions: attend the ED, and stay at home and monitor symptoms. The authors reported the triage dispositions of patients as follows: 28 calls were directed to attend the ED (62.2%) and 17 calls were directed to monitor at home (37.8%) [41]. There was no adjustment for confounders and the certainty of the evidence was very low.

The third study, a cluster RCT (comprising 200 patients with hereditary angioedema), reported on triage disposition outcomes in the intervention group compared with the usual care group over a 2-year period [40]. This study reported no significant difference in patients directed to monitor at home in the intervention group (81% of patients) compared with the usual care group (74% of patients) (RD: 7.0; 95% CI: −4.5 to 18.5; *p*-value not reported; findings not statistically significantly different) [40]. The certainty of the evidence was very low. There were no interpretable outcomes on ED attendances in the cluster RCT.

Table 12 Summary of evidence on triage disposition in specific triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment/risk of bias	GRADE certainty of evidence	Triage disposition rates (%)
Triage disposition Engeltjes *et al.* (2021) [39]	• High: U1 (resuscitation and life-threatening) and U2 (emergency) • Intermediate: U3 (urgent) and U4 (non-urgent)	Pregnant women (n=983 calls)	Surveillance system	Moderate	Very low	63.6% of calls were triaged to the high urgency level (U1: 0.3%; U2: 63.3%) 36.4% of calls were triaged to the intermediate urgency level (U3: 29.0%; U4: 7.4%)
Triage disposition Kukulka *et al.* (2020) [41]	• Go to ED • Stay at home and monitor symptoms	People with myasthenia gravis (n=45 calls)	Surveillance system	High	Very low	62.2% of calls were directed to go to the ED 37.8% of calls were directed to monitor at home
Triage disposition Javaud *et al.* (2018) [40]	Not reported	People with chronic hereditary angioedema (n=200 patients)	Cluster RCT	Low	Very low	No significant difference in the proportion of patients directed to monitor at home between intervention (81.0%) and control (74.0%) groups

3.7.1.2.2 ED attendance

One study (comprising 25 patients who made 45 calls) reported very low-certainty evidence on ED attendance in a specific triage service (delivery of the single-breath count test to people with myasthenia gravis over the telephone) (Table 13) [41]. This study reported that 73.3% of calls (33 of the 45 calls) resulted in an ED presentation. We note that actual ED attendance by call is not clear from the paper, but we have reported this here based on the assumption that those with no exacerbation who were not advised to go to the ED did not attend the ED. ED attendance thus included 28 callers who were directed to attend the ED as they scored ≤25 on their single-breath count test (defined as cases advised to attend the ED), as well as 5 callers who scored >25 (defined as not requiring ED attendance) but self-presented

to the ED and were deemed by a specialist to have an exacerbation [41]. There was no adjustment for confounders.

Table 13 Summary of evidence on ED attendance in a specific triage service

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	ED attendance rate (%)
ED attendance Kukulka *et al.* (2020) [41]	• Go to ED • Stay at home and monitor symptoms	People with myasthenia gravis (n=45 calls)	Surveillance system	Low	Very low	73.3% of calls resulted in an ED attendance

3.7.1.2.3 Overtriage

Two studies reported very low-certainty evidence on overtriage rates in specific triage services [39,41]; these studies reported overall overtriage rates of 30.3% and 17.8% among their respective study populations, or 30.3% and 28.6% based on only those directed to go to the hospital. Overtriage is defined as a triage decision that classifies patients as needing a higher level of care than was actually needed. A summary of the evidence on overtriage rates is presented in Table 14.

The first study (comprising 983 calls from pregnant women) examined the effect of using a specific triage line for pregnant women across four hospitals in the Netherlands, excluding women triaged to self-care [39]. Overtriage was determined by comparing the urgency level determined over the phone with a reference standard, which was the urgency attributed at follow-up clinical face-to-face assessment in hospital (as determined by a medical doctor (obstetrician in training) or midwife). Comparing the urgency level determined over the telephone with in-person clinical assessment, this study reported that overtriage occurred in 30.3% of calls (n=298 out of 983). In 73.8% of these overtriaged calls (n=220 out of 298), the degree of overtriage was one urgency level (e.g. the call was deemed to be a U3 instead of U2 following clinical face-to-face assessment), and in 26.2% of overtriaged calls (n=78 out of 298), the amount of overtriage was two or more urgency levels (e.g. the call was deemed to be a U4 instead of U2 following clinical face-to-face assessment). All those triaged to the most urgent triage disposition of U1 (i.e. life-threatening emergency) received the same status at the hospital [39]. There was no adjustment for confounders and the certainty of the evidence was very low.

The second study (N=25 patients; 45 calls) reported eight calls where patients failed the single-breath count test over the telephone, but when these patients presented to the ED, they were found to not be experiencing an exacerbation of myasthenia gravis by an on-call specialist neurologist [41]. Therefore, an overall overtriage rate of 17.8% (n=8 out of 45 calls) occurred during this study. Of those directed to the ED, 28.6% did not have an exacerbation (n=8 out of 28 calls), resulting in a false positive rate of 40.0% [41]. There was no adjustment for confounders and the certainty of the evidence was very low.

Table 14 Summary of evidence on overtriage rates in specific triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Overtriage rate (%)
Overtriage Engeltjes *et al.* (2021) [39]	• High: U1 (resuscitation and life-threatening) and U2 (emergency) • Intermediate: U3 (urgent) and U4 (non-urgent)	Pregnant women (n=983 calls)	Surveillance system	Moderate	Very low	30.3% were overtriaged compared with in-person clinical assessment at hospital
Overtriage Kukulka *et al.* (2020) [41]	• Go to ED • Stay at home and monitor symptoms	People with myasthenia gravis (n=45 calls)	Surveillance system	High	Very low	Overall, 17.7% were overtriaged compared with neurologist assessment at the ED 28.6% were overtriaged among those directed to the ED

3.7.1.2.3.1 Subgroup comparisons for overtriage

A similar rate of overtriage among those triaged to go to hospital was observed across these two studies – 28.6% [41] compared with 30.3% [39] – despite different types of staff completing triage: nurses only in one study [41] and obstetric nurses or doctor's assistants in the second study [39]. However, the patient populations were different, with people with chronic myasthenia gravis in the first study [41] and pregnant women in the second study [39]. In addition, the two studies reported using different technology, i.e. flash cards [41] compared with a digital app that supported telephone triage in the hospital's information system [39].

3.7.2 General triage services

3.7.2.1 Safety

Eleven studies assessed the safety of general triage services (Table 6). The safety outcomes measured were mortality (three studies), hospital admissions (five studies), and other indicators of undertriage (nine studies).

3.7.2.1.1 Mortality

3.7.2.1.1.1 Same-day mortality

One study reported very low-certainty evidence on same-day mortality outcomes [49]. A summary of the evidence on same-day mortality is presented in Table 15.

This study examined 4,962 unique callers triaged to Level E (i.e. non-urgent callers who were not sent an ambulance, including 16% who were directed to attend the ED) and reported an overall same-day mortality rate of 0.12% (6 out of 4,962 unique callers). The six patients who died included three who were terminally ill, two with dizziness and fatigue, and one patient who had been incorrectly categorised via a typing error "with a reminder of an ambulance" [49] despite being ultimately triaged as a Level E patient [49]. There was no adjustment for confounders, but the characteristics of the six patients who were reported to have died on the same day as their call were explored. The six people who died had an older median age of 77.1 years (interquartile range: 54.5–92.6 years) compared with 47 years (interquartile range: 24.3–67.7 years) in the overall sample. There was an even split of men and women among the patients who died compared with 53.4% men and 46.6% women in the overall sample. Four of the six deceased patients (66.7%) were referred to a GP compared with 56.1% of the overall sample. There was a large proportion (47.2%) of Level E calls for which follow-up data were missing due to invalid unique civil registration numbers preventing data linkage [49]. There was no adjustment for confounders.

Table 15 Summary of evidence on same-day mortality outcomes in general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Mortality rate (%)
Same-day mortality Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962 unique patients)	Surveillance system	Low	Very low	0.12% triaged below ambulance

3.7.2.1.1.2 Seven-day mortality

Two studies reported very low-certainty evidence on mortality outcomes at 7 days following the use of general triage services [42,49]. Hodgins *et al.* reported an overall mortality rate of 0.02% (n=17 out of 85,861 calls) among young adults with chest pain calling National Health Service (NHS) 24 who were triaged below the triage disposition 'call an ambulance' [42]. This compares with a mortality rate of 0.8% (n=38 out of 4,962 patients) among Level E patients (who may be directed to attend the ED but are not dispatched an ambulance) in the Central Denmark Region [49]. Table 16 presents a summary of 7-day mortality outcomes in general triage services.

Table 16 Summary of evidence on 7-day mortality outcomes in general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Mortality rate (%)
Seven-day mortality Hodgins *et al.* (2022) [42]	• Call an ambulance • Self-transport to ED • GP house visit within 1-hour • GP house visit within 2-hours • Primary care out-of-hours (PCOOH) appointment within 1-hour • PCOOH appointment within 2-hours • PCOOH appointment within 4-hours • GP house visit within 4-hours • Scheduled appointment • Self-care	All calls by young adults aged 15–34 years with chest pain (n=97,619 callers)	Surveillance system	Low	Very low	0.02% triaged below ambulance and ED
Seven-day mortality Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962 unique patients)	Surveillance system	Low	Very low	0.8% triaged below ambulance

The first study (n=97,619 callers) analysed data on continuous urgent care pathways for young adults with chest pain calling NHS 24 over a 3-year period [42]. Hodgins *et al.* reported a 7-day mortality rate of 0.01% (2 out of 26,151 callers) among callers triaged to non-urgent care in the form of a scheduled appointment or self-care (i.e. not triaged to receive care within 4 hours) and 0.02% (17 out of 79,770 callers) among all callers triaged to below the need for an ambulance/to attend the ED (i.e. they were not instructed to call an ambulance or self-transport to ED). Table 17 presents the 7-day mortality rate by triage disposition. Triage disposition data were missing for 5.1% of callers (n=5,203 out of 102,822 total callers) [42]. There was no adjustment for confounders and the GRADE certainty of evidence was very low.

Table 17 Seven-day mortality rate by triage disposition for all callers in Hodgins et al. (2022)

	Triage disposition	Mortality rate (%)	Number of deaths	Number of callers
Urgent care (i.e. within 4 hours)	Call an ambulance	0.06	7	11,758
	Self-transport to ED	0.00	0	6,091
	GP house visit within 1-hour	1.54	2	130
	GP house visit within 2-hours	0.40	2	498
	Primary care out-of-hours (PCOOH) appointment within 1-hour	0.05	3	5,697
	PCOOH appointment within 2-hours	0.04	3	8,390
	PCOOH appointment within 4-hours	0.01	4	37,976
	GP house visit within 4-hours	0.11	1	928
Non-urgent care	Scheduled appointment	0.01	2	17,698
	Self-care	0.00	0	8,453

Source: Hodgins *et al.* 2022 [42]

The second study, by Lehm *et al.* (2017) (N=4,962 unique patients), examined 7-day mortality in non-urgent Level E patients in the Central Denmark Region [49]. While Level E patients are considered non-urgent callers, 16% were directed to attend the ED. Analysis was based on the first call to the triage service by unique patients, with repeat calls excluded. The overall reported mortality rate among Level E callers at 7 days was 0.8% (n=38 out of 4,962 patients). There was a large proportion (47.2%) of Level E calls for which follow-up data were missing due to invalid unique civil registration numbers preventing data linkage [49]. There was no adjustment for confounders and the evidence was of very low certainty.

3.7.2.1.1.3 Thirty-day mortality

Two studies reported very low-certainty evidence on mortality outcomes at 30 days following the use of general triage services [44,49]. A summary of the evidence on 30-day mortality is presented in Table 18.

The first study (comprising 4,962 unique patients) examined 30-day mortality in non-urgent Level E patients (who may be directed to ED but are not dispatched an ambulance) [49]. The mortality rate for Level E patients was 1.5% at 30 days (n=74 out of 4,962 patients). There was a large proportion (47.2%) of Level E calls for which follow-up data were missing [49].

The second study, by Sax *et al.* (2018), comprised 29,673 unique callers aged 36 years and over with chest pain recorded as the reason for their call and compared a usual care pathway (nurse-provided telephone triage using a predetermined algorithm with physician consultation as needed when triggered by the algorithm) with a physician-only telephone triage (physicians only used their clinical judgement and the patient's electronic health record rather than following a predetermined algorithm) protocol over a 30-day period [44]. Pregnant women (n=119), non-English-language callers (n=8,115), callers who had upper respiratory infection complaints or who were trauma victims (n=241) were also excluded from the research. Propensity matching on patient characteristics (age, sex, race/ethnicity, comorbidities, ED co-payment terms, a visit to ED/hospital/office in last 12 months and call centre utilisation in past 12 months) and call characteristics (particular call centre, time of call, month of call) was then used in order

to minimise differences in calls routed to nurses versus those routed to physicians. Overall, the mortality rate for callers triaged to dispositions below ED (i.e. clinic appointment, telephone appointment, or message sent to the patient's primary care provider) was 0.20%, with a rate of 0.22% in calls routed to nurses (usual care pathway) compared with a rate of 0.19% in calls routed to physicians. Repeat callers (18.0%, n=7,058 out of 39,197 callers) and calls with data that could not be linked (6.3%, n=2,466 out of 39,197 calls) were excluded from the analysis [44]. Overall, the evidence was of very low certainty.

Table 18 Summary of evidence on 30-day mortality outcomes in general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Mortality rate (%)
Thirty-day mortality Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962 unique patients)	Surveillance system	Low	Very low	1.5% triaged below ambulance
Thirty-day mortality Sax *et al.* (2018) [44]	• ED visit • Below ED (clinic appointment, telephone appointment, or message sent to the patient's primary care provider)	Adults aged 36 years and over with chest pain (12,064 physician-directed calls and 17,609 nurse-directed calls prior to propensity matching)	Surveillance system	High	Very low	0.20% triaged below ambulance and ED (0.22% nurse calls; 0.19% physician calls)

3.7.2.1.2 Hospital admissions

3.7.2.1.2.1 Within 1 day of using general triage services

Two studies reported very low-certainty evidence on hospital admission outcomes within 1 day of using general triage services [49,50]. A summary of the evidence on hospital admission outcomes within 1 day is presented in Table 19.

The first study (comprising 4,962 unique patients) examined callers triaged to Level E (i.e. non-urgent callers who were not sent an ambulance, including 16% who were directed to attend the ED) and reported that the overall admission rate for Level E patients within 1 day was 8.6% (n=425 out of 4,962 patients) [49]. Repeat calls were excluded and patients were triaged by a nurse, doctor, or paramedic using dispatch software with no separation of results based on triageur. There was a large proportion (47.2%) of Level E calls for which follow-up data were missing due to invalid unique civil registration numbers preventing data linkage [49]. There was no adjustment for confounders and the evidence was of very low certainty.

The second study (comprising 1,089 calls) examined hospital admissions within 1 day among calls triaged to non-emergency care after calling a general triage service in emergency medical dispatch centres in two counties in Sweden [50]. Calls were triaged by nurses who used a clinical decision support system in 69.8% of calls. Of note, the analysis of the hospital admissions outcome is not based on the use of the clinical decision support system. Non-emergency care in this case meant that calls were triaged to below the need for an ambulance or taking alternate transport to the ED; among these calls, 5.4% were admitted to hospital within 1 day (n=59 out of 1,089 calls). This rate is not adjusted for confounders, but the authors did provide logistic regression sensitivity analysis in graph form (adjusting for sex, age,

weekday call, daytime call, prior contact, county, decision support used, and onward referral) which indicated that those aged 65 years and over were more likely to be admitted to hospital within 1 day of triage decision (no statistics were extractable; a graph illustrated the line of significance only). Spangler *et al*. reported significant data linkage issues, with data missing for 35.8% of calls; this was either due to data entry issues (2.1%; n=36 out of 1,696 calls) or to missing personal identification numbers (33.7%; n=571 out of 1,696 calls). According to the authors, calls missing personal identification numbers were significantly associated with the non-emergency triage disposition in this service and were commonly due to a third-party caller, reduced mental status, and dispatch error (with no breakdown of the proportion of calls attributed to each of these causes being provided in the study). The outcome of hospital admission was collected by two nurses from medical records and had an agreement level of 93.7% (alpha=0.94) [50]. Overall, the certainty of the evidence was very low.

Table 19 Summary of evidence on hospital admission outcomes within 1 day of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Admissions rate (%)
Hospital admission outcomes within 1-day Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962)	Surveillance system	Low	Very low	8.6% triaged below ambulance
Hospital admission outcomes within 1-day Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Calls triaged to non-emergency care (n=1,089 calls)	Surveillance system	High	Very low	5.4% triaged below ambulance and ED

3.7.2.1.2.2 Within 2 days of using general triage services

One study reported very low-certainty evidence on hospital admission outcomes within 2 days of using general triage services [48]. A summary of the evidence on hospital admission outcomes within 2 days (or 48 hours) is presented in Table 20.

This study (comprising 103,768 calls) examined patients in metropolitan Melbourne who were initially deemed low acuity by the Australian emergency telephone number and referred onto a regional referral service to receive telephone triage [48]. Triage was completed by a trained nurse or paramedic using a condition-specific computer-based questioning algorithm (known as Care Enhanced Call Centre) with no separation of results based on triageur. Overall, 6.5% of calls triaged to the 'alternative care pathway' (i.e. triaged below ambulance dispatch or ED referral) were admitted to a hospital within 48 hours of the call. This alternative care pathway included two levels: dispatch of alternate service providers (GP locums, nurses, crisis assessment and treatment teams, hospital community programmes, and others), and self-care advice (which in this case could be either home self-care or a referral to visit the patient's own healthcare professional). Hospital admission rates within 48 hours were 11.1% for those dispatched alternative service providers and 5.1% for those provided self-care advice. Absolute risk percentages were provided, and overall, calls triaged to ambulance or ED referral were significantly more likely to be admitted to hospital (absolute risk: 53.8%) than calls triaged to the alternative care pathway (absolute risk: 43.5%; odds ratio (OR): 1.5; 95% CI: 1.4–1.6; p<0.001). The alternative care pathway comprised self-

care (absolute risk: 39.4%) and dispatch of alternative service providers (absolute risk: 51.3%). The authors reported significant data linkage issues. Overall, 84.1% (n=103,768 out of 123,458 calls) of all cases triaged by the service had service case records available [48], and further uncalculated loss to follow-up in relation to hospital admissions was also reported. There was no adjustment for confounders and the evidence was of very low certainty.

Table 20 Summary of evidence on hospital admission outcomes within 2 days of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Admissions rate (%)
Hospital admission outcomes within 2-days Eastwood *et al.* (2017) [48]	Emergency care pathway: • Return for emergency ambulance dispatch • Non-emergency ambulance dispatch • Self-present at the ED Alternative care pathway: • Alternative service providers dispatched • Self-care (home self-care or a referral to visit their own healthcare professional)	Callers in metropolitan Melbourne deemed low acuity by the Australian emergency telephone number (n=103,768 calls)	Surveillance system	Low	Very low	6.5% triaged below ambulance and ED Those triaged below ambulance and ED referral had a significantly lower likelihood of hospital admission

3.7.2.1.2.3 Within 3 days of using general triage services

Two studies reported very low-certainty evidence on hospital admission outcomes within 3 days of using general triage services [50,52]. A summary of the evidence on hospital admission outcomes within 3 days is presented in Table 21. **Error! Reference source not found.**Among calls triaged to below the need for an ambulance or presentation to the ED, Spangler *et al*. (2020) reported a 3-day admission rate of 7.1%, while Lewis *et al*. (2021) reported a 3-day admission rate of 4.2%.

The first study (comprising 1,089 calls) examined hospital admissions within 3 days among calls triaged to non-emergency care after calling a general triage service in emergency medical dispatch centres in two counties in Sweden [50]. Calls were triaged by nurses who used a clinical decision support system in 69.8% of calls. Non-emergency care in this case meant that patients were triaged to below the need for an ambulance or taking alternate transport to the ED; among these calls, 7.1% were admitted to hospital within 3 days (n=77 out of 1,089 calls). This rate is not adjusted for any confounders, but the authors did

provide logistic regression sensitivity analysis in graph form (adjusting for sex, age, weekday call, daytime call, prior contact, county, decision support used, and onward referral) which indicated that those aged 65 years and over were more likely to be admitted to hospital within 3 days of triage decision (no statistics were extractable; a graph illustrated the line of significance only). Spangler *et al*. reported significant data linkage issues, with data missing for 35.8% of calls; this was either due to data entry issues (2.1%; n=36 out of 1,696 calls) or to missing personal identification numbers (33.7%; n=571 out of 1,696 calls). The outcome of hospital admission was collected from medical records by two nurses and had an agreement level of 93.7% (alpha=0.94) [50]. Overall, the certainty of the evidence was very low.

The second study (comprising 3,614,915 calls) analysed all calls of every triage disposition to NHS 111 in the Yorkshire and Humber regions in the UK over a 4-year period. Calls were triaged by call handlers without clinical backgrounds, with some clinical advisors available to provide support for challenging cases (although outcomes were not fully analysed on this basis) [52]. No computer decision support was reported, but NHS 111 is known to employ such a system [54]. The 3-day admission rate for those triaged to below the need for an ambulance or presentation to the ED (primary or community care; self-care; directed to other service) was 4.2% (n=125,368 out of 2,956,204 calls),and was 3.8% (n=106,207 out of 2,767,106 calls) when excluding those directed to other services (e.g. mental health services, a district nurse, or a midwife). There was no adjustment for confounders in the form of significance testing, but subgroups based on age groups and the use of clinical advisor support were illustrated using graphs and reported on in the text. It was reported that higher proportions of older adults were admitted to hospital following an ED attendance, even for low-acuity triage dispositions (self-care or contact primary/community care), with 60% of older adults (aged 75 years and over) who were triaged to self-care being admitted to hospital compared with 20% of those aged 16–44 years who were triaged to self-care, suggesting that older adults may be more likely to be undertriaged. This study also reported that across all age groups and triage dispositions, with the exception of those aged 16–44 years who were advised to attend the ED, larger numbers of patients were admitted than were classed as non-urgent. Subgroup analysis also identified that, of callers who were originally advised to attend the ED, fewer of those who were handled by a non-clinical call handler were admitted than classed as non-urgent. Among those triaged to 'other services', admissions occurred far more frequently for those who were handled by a non-clinical advisor than among those who were handled by a clinical call handler. Lewis *et al.* noted, however, that clinical advisors may be more likely to deal with borderline or complex cases, and clinical advisors directed far more callers to other services compared with non-clinical call handlers, which is likely due to their understanding of the services available and when to direct callers to those services. Data were missing for 0.4% of calls, which were excluded from analysis (n=16,154 out of 3,631,069 calls) [52]. The certainty of the evidence was very low.

Table 21 Summary of evidence on hospital admission outcomes within 3 days of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Admissions rate (%)
Hospital admission outcomes within 3-days Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Calls triaged to non-emergency care in two counties in Sweden (n=1,089 calls)	Surveillance system	High	Very low	7.1% triaged below ambulance and ED
Hospital admission outcomes within 3-days Lewis *et al.* (2021) [52]	High acuity: • Transferred for ambulance dispatch • Attend ED Low acuity: • Seek primary or community care • Seek other service (e.g. mental health services, a district nurse, or a midwife) • Self-care	NHS 111 calls in the Yorkshire and Humber regions (n=3,614,915)	Surveillance system	High	Very low	4.2% triaged below ambulance and ED (3.5% of all calls undertriaged based on admissions)

3.7.2.1.2.3.1 Subgroup comparisons for hospital admission outcomes within 3 days

Among calls triaged to below the need for an ambulance or presentation to the ED, Spangler *et al.* (2020) reported a 3-day hospital admission rate of 7.1%, while Lewis *et al.* (2021) reported a 3-day admission rate of 4.2% [50,52]. Both studies assessed regional data from a national service dataset. Spangler *et al*. reported that decision support was used in 69.8% of calls and triage was done by nurses, while Lewis *et al.,* was based on NHS 111 which is known to use decision support software and, reported triage was conducted by non-clinical call handlers with the support of clinical advisors where needed [50,52].This pattern suggests that consistent use of a decision support system even with non-clinical call handlers may be associated with lower admission rates within 3 days of using a general triage service, but it is not possible to draw a strong conclusion given the lack of adjustment for confounders and the very low certainty of the evidence.

3.7.2.1.2.4 Within 7 days of using general triage services

Three studies reported very low-certainty evidence on hospital admission outcomes within 7 days of using general triage services [42,49,50]. A summary of the evidence on hospital admission outcomes within 7 days is presented in Table 22.

Table 22 Summary of evidence on hospital admission outcomes within 7 days of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Admissions rate (%)
Hospital admission outcomes within 7-days Hodgins *et al.* (2022) [42]	• Call an ambulance • Self-transport to ED • GP house visit within 1-hour • GP house visit within 2-hours • Primary care out-of-hours (PCOOH) appointment within 1-hour • PCOOH appointment within 2-hours • PCOOH appointment within 4-hours • GP house visit within 4-hours • Scheduled appointment • Self-care	All calls by young adults aged 15–34 years with chest pain (n=97,619 callers)	Surveillance system	High	Very low	6.8% triaged below ambulance and ED Compared with self-care, all other triage dispositions had significantly higher admission rates
Hospital admission outcomes within 7-days Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Calls triaged to non-emergency care (n=1,089 calls)	Surveillance system	High	Very low	9.1% triaged below ambulance and ED
Hospital admission outcomes within 7-days Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962)	Surveillance system	Low	Very low	10.5% triaged below ambulance

The first study (n= 97,619 callers) analysed data on continuous urgent care pathways for young adults with chest pain calling NHS 24 over a 3-year period. Hodgins *et al.* reported an admission rate of 3.4% (n=884 out of 26,151 callers) among all callers who were triaged to non-urgent care in the form of a scheduled appointment or self-care (i.e. not triaged to receive care within 4 hours) and 6.8% (n=5,448 out

of 79,770 callers) among all callers who were triaged to below the need for an ambulance or presentation to the ED (i.e. callers were not instructed to call an ambulance or to self-transport to the ED) [42]. The admission rate by each individual triage disposition as well as univariate and adjusted ORs of hospital admission are presented in Table 23. Compared with self-care, all other triage dispositions had significantly higher admission rates, suggesting good accuracy for triaging more urgent callers above the self-care level [42].

Table 23 Seven-day admission rate by triage disposition for all callers in Hodgins et al. (2022)

	Triage disposition	Admission rate (%)	Number of admissions	Number of callers	OR (95% CI)	Adjusted OR (95% CI)
Urgent care (i.e. within 4 hours)	Call an ambulance	20.6	2,422	11,758	29.7 (23.6–37.7)	28.7 (22.6–36.3)
	Self-transport to ED	13.5	825	6,091	18.0(14.1–22.9)	17.8 (14.0–22.7)
	GP house visit within 1-hour	24.6	32	130	37.5 (23.6–59.4)	36.8 (23.2–58.5)
	GP house visit within 2-hours	24.5	122	498	37.2 (27.4–50.7)	35.9 (26.3–48.9)
	Primary care out-of-hours (PCOOH) appointment within 1-hour	14.0	800	5,697	18.8 (14.7–23.9)	18.5 (14.5–23.6)
	PCOOH appointment within 2-hours	11.9	998	8,390	15.5 (12.2–19.7)	15.4 (12.1–19.5)
	PCOOH appointment within 4-hours	6.5	2,475	37,976	8.0 (6.3–10.1)	7.9 (6.2–10.0)
	GP house visit within 4-hours	14.8	137	928	19.9 (14.8–26.7)	19.0 (14.1–25.5)
Non-urgent care	Scheduled appointment	4.6	811	17,698	5.5 (4.3–7.0)	5.5 (4.3–7.0)
	Self-care	0.9	73	8,453	Reference	Reference

Source: Hodgins *et al.,* 2022 [42]

Hospital admission by triage disposition was adjusted for sex, age, remoteness (driving distance), and level of deprivation [42]. Overall, weak but statistically significant associations were reported between odds of admission and the two older age groups (e.g. those aged 30–34 years (OR: 1.3; 95% CI: 1.2–1.4)) compared with the youngest age group (those aged 15–19 years) and socioeconomic deprivation from Levels 1 to 4 (e.g. Level 1 or the highest level of deprivation: OR: 1.3; 95% CI: 1.2–1.4) compared with Level 5 or the lowest level of deprivation. Sex and remoteness were not significant. Triage disposition data were missing for 5.1% of callers (n=5,203 out of 102,822 callers) [42]. The evidence was of very low certainty.

The second study (comprising 1,089 calls) examined hospital admissions within 7 days among calls that were triaged to non-emergency care after calling a general triage service in emergency medical dispatch centres in two counties in Sweden [50]. Calls were triaged by nurses who used a clinical decision support system in 69.8% of calls. Non-emergency care in this case meant that patients were triaged to below the

need for an ambulance or taking alternate transport to the ED; among these calls, 9.1% were admitted to hospital within 7 days (n=99 out of 1,089 calls). This rate is not adjusted for confounders, but the authors did provide logistic regression sensitivity analysis in graph form (adjusting for sex, age, weekday call, daytime call, prior contact, county, decision support used, and onward referral) which indicated that those aged 65 years and over were more likely to be admitted to hospital within 7 days of the triage decision (no statistics were extractable; a graph illustrated the line of significance only). Spangler *et al.* reported significant data linkage issues, with data missing for 35.8% of calls; this was either due to data entry issues (2.1%; n=36 out of 1,696 calls) or to missing personal identification numbers (33.7%; n=571 out of 1,696 calls) [50]. The outcome of hospital admission was collected from medical records by two nurses and had an agreement level of 93.7% (alpha=0.94) [50]. Overall, the certainty of the evidence was very low.

The third study examined 4,962 unique callers triaged to level E (i.e. non-urgent callers who were not sent an ambulance, including 15.9% known to have been directed to attend the ED) and reported that the overall admission rate for Level E patients within 7 days was 10.5% (n=523 out of 4,962 patients) [49]. Repeat calls were excluded and patients were triaged by a nurse, doctor, or paramedic using dispatch software with no separation of results by triageur. There was a large proportion (47.2%) of Level E calls for which follow-up data were missing due to invalid unique civil registration numbers preventing data linkage [49]. There was no adjustment for any confounders and the evidence was of very low certainty.

3.7.2.1.2.5 Within 30 days of using general triage services

One study reported very low-certainty evidence on hospital admission outcomes within 30 days of using general triage services [49]. A summary of the evidence on hospital admission outcomes within 30 days is presented in Table 24.

This study (comprising 4,962 unique patients) examined callers triaged to Level E (i.e. non-urgent callers who were not sent an ambulance, including 15.9% known to have been directed to attend the ED) and reported that the overall admission rate for Level E patients within 30 days was 12.0% (n=593 out of 4,962 patients) [49]. Repeat calls were excluded and patients were triaged by a nurse, doctor, or paramedic using dispatch software with no separation of results by triageur. There was a large proportion (47.2%) of Level E calls for which follow-up data were missing due to invalid unique civil registration numbers preventing data linkage [49]. There was no adjustment for confounders and the evidence was of very low certainty.

Table 24 Summary of evidence on hospital admission outcomes within 30 days of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Admissions rate (%)
Hospital admission outcomes within 30-days Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962)	Surveillance system	Low	Very low	12.0% triaged below ambulance

3.7.2.1.3 Other indicators of undertriage

3.7.2.1.3.1 Accuracy: Remote triage assessment compared with face-to-face assessment

3.7.2.1.3.1.1 Within 6 hours of using general triage services

One study provided evidence on the accuracy of remote triage compared with face-to-face assessments within 6 hours of receiving general triage services in Japan [51]. A summary of the evidence is presented in Table 25.

In this study (comprising 19,114 calls triaged to visit a hospital within 1 or 6 hours), triage was conducted by a nurse with follow-up face-to-face assessment by a doctor at the patient's own home. Patients deemed by the doctor to need an ambulance were defined as undertriaged calls, with an undertriage rate of 1.6% reported (n=289 out of 19,114 calls). Follow-up data were missing for 1.9% (n=363) of calls included, and these patients were significantly different based on age, sex, comorbidities, and symptoms reported during triage [51]. There was a discrepancy of 3 out of 19,114 calls which were not reported as missing nor assigned a follow-up status and this was not explained by the authors. There was no adjustment for confounders and the evidence was of very low certainty.

Table 25 Summary of evidence on accuracy outcomes for remote general triage services compared with face-to-face assessment within 6 hours

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Undertriage rate (%)
Accuracy based on face-to-face assessment at patient's home Inokuchi *et al.* (2022) [51]	• Hospital within 1 hour • Hospital within 6 hours	Calls from general patients with mid-level triage dispositions (i.e. triaged as needing to visit a hospital within 1 hour (orange) (n=10,547 calls) or 6 hours (yellow) (n=8,567 calls))	Surveillance system	High	Very low	1.6% of those triaged below ambulance and above hospital within 24 hours

3.7.2.1.3.1.2 Within 1 day of using general triage services

One study provided very low-certainty evidence on the accuracy of remote triage compared with face-to-face assessments within 1 day of using general triage services [50]. A summary of the evidence is presented in Table 26.

This study (comprising 1,089 calls) included calls that were triaged to non-emergency care after calling a general triage service in emergency medical dispatch centres in two counties in Sweden [50]. Calls were triaged by nurses who used a clinical decision support system in 69.8% of calls. Of note, the analysis of

remote triage accuracy is not based on the use of the clinical decision support system. Non-emergency care in this case meant that patients were triaged to below the need for an ambulance or taking alternate transport to the ED. Callers who were triaged to non-emergency care but who presented to the ED and were judged to need ED treatment at specialist level or to need specialist interventions (i.e. the provision of care above the primary level) were deemed to be undertriaged for the purposes of this review. An undertriage rate of 8.7% (n=95 out of 1,089 calls) was reported in this study based on those who presented to the ED and were judged to need care above the assigned triage disposition level. This rate is not adjusted for confounders, but the authors did provide logistic regression sensitivity analysis in graph form (adjusting for sex, age, weekday call, daytime call, prior contact, county, decision support used, and onward referral) which indicated that those aged 65 years and over were more likely to need specialist intervention within 1 day of triage decision [50] (no statistics were extractable; a graph illustrated the line of significance only).

Spangler *et al.* reported significant data linkage issues, with data missing for 35.8% of calls; this was either due to missing personal identification numbers (33.7%; n=571 out of 1,696 calls) or to data entry issues (2.1%; n=36 out of 1,696 calls) [50]. There was 62.5% agreement by two raters on whether specialist care had been administered or not (for the entire 7-day follow-up period) (alpha=0.7). Five of seven disagreements between the raters regarding the care level resulted from a difference in opinion on whether standard panel blood tests should be classified as specialist care [50]. Overall, the certainty of the evidence was very low.

Table 26 Summary of evidence on accuracy outcomes for remote general triage services compared with face-to-face assessment within 1 day

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Undertriage rate (%)
Accuracy based on face-to-face assessment at ED within 1-day Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Calls triaged to non-emergency care (n=1,089 calls)	Surveillance system	High	Very low	8.7% triaged below ambulance and ED

3.7.2.1.3.1.3 Within 2 days of using general triage services

Two studies reported very low-certainty evidence on the accuracy of remote triage compared with face-to-face assessments within 2 days (or 48 hours) of using general triage services [48,52]. A summary of the evidence on the accuracy of remote triage compared with face-to-face assessments within 2 days is presented in Table 27. Among calls triaged to below the need for an ambulance or presentation to the ED, Lewis *et al.* reported that 9.6% of those who presented to the ED were not 'non-urgent', while Eastwood *et al.* reported that 9.5% were 'ED suitable'.

The first study (n=3,614,915 calls) analysed all calls of every triage disposition to NHS 111 in the Yorkshire and Humber regions in the UK over a 4-year period. Calls were triaged by call handlers without clinical backgrounds, with some clinical advisors available to provide support for challenging cases (although outcomes were not fully analysed on this basis) [52]. No computer decision support was reported, but NHS 111 is known to use technical support. For the purposes of this review, those triaged below ED who attended the ED and were not classed as 'non-urgent' were considered undertriaged. In this study, the

undertriage rate for calls triaged to below the need for an ambulance or presentation to the ED (primary or community care; self-care; directed to other services) was 9.6% (n=284,962 out of 2,956,204 calls) [52]. There was no adjustment for confounders and the evidence was of very low certainty.

The second study (comprising 103,768 calls) examined patients in metropolitan Melbourne who were initially deemed low acuity by the Australian emergency telephone number and referred onto a regional referral service to receive telephone triage [48]. Triage was completed by a trained nurse or paramedic using a condition-specific computer-based questioning algorithm (known as Care Enhanced Call Centre) with no separation of results by triageur. On presentation to the ED, all patients were assessed for ED suitability. For the purposes of this review, those who presented to the ED and were deemed 'ED suitable' but had been triaged to below the need for an ambulance or ED referral (i.e. dispatched to alternative service providers and self-care) were considered undertriaged. An undertriage rate of 9.5% (n=3,005 out of 31,627 calls) was reported for all calls triaged to below the need for an ambulance or ED referral, meaning that these calls were deemed ED suitable on presentation to the ED. By individual triage disposition, the undertriage rate was 14.7% among those dispatched alternative service providers and 8.2% among those triaged to self-care (which in this case could be either home self-care or a referral to visit the patient's own healthcare professional). Absolute risk percentages were provided, and overall, calls triaged to ambulance or ED referral were significantly more likely to be ED suitable (absolute risk: 74.3%) than 'unplanned' ED presentations from calls triaged to the alternative care pathway (absolute risk: 64.1% (OR: 1.62; 95% CI: 1.5–1.7; $p<0.001$)). 'Unplanned' ED presentations from calls triaged to the alternative care pathway comprised those dispatched to self-care (absolute risk: 60.3%) and those dispatched alternative service providers (absolute risk: 68.8%). The authors reported significant data linkage issues both specific to this outcome and overall. Specific to this outcome, no records were available for assessments at private hospitals unless patients were admitted [48]. Overall, 88.1% (n=103,768 out of 123,458) of all cases triaged by the triage service had service case records available, and further loss to follow-up in relation to ED presentations is unknown. There was no adjustment for confounders and the evidence was of very low certainty.

Table 27 Summary of evidence on accuracy outcomes for remote general triage services compared with face-to-face assessment within 2 days

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Undertriage rate (%)
Accuracy based on face-to-face assessment at ED within 2-days Lewis *et al.* (2021) [52]	High acuity: • Transferred for ambulance dispatch • Attend ED Low acuity: • Seek primary or community care • Seek other service (e.g. mental health services, a district nurse, or a midwife) • Self-care	NHS 111 calls in the Yorkshire and Humber regions (n=3,614,915)	Surveillance system	High	Very low	9.6% triaged below ambulance and ED 7.9% of all calls
Accuracy based on face-to-face assessment at ED within 2-days Eastwood *et al.* (2017) [48]	Emergency care pathway: • Return for emergency ambulance dispatch • Non-emergency ambulance dispatch • Self-present at the ED Alternative care pathway: • Alternative service providers dispatched • Self-care (home self-care or a referral to visit their own healthcare professional)	Callers in metropolitan Melbourne deemed low acuity by the Australian emergency telephone number (n=103,768 calls)	Surveillance system	Low	Very low	9.5% triaged below ambulance and ED Those triaged to below the need for an ambulance or ED referral were significantly less likely to be 'ED suitable'

3.7.2.1.3.1.3.1 Subgroup comparisons based on face-to-face assessment in hospital within 2 days

Similar rates of undertriage were seen in these two studies based on ED presentations by general callers within 48 hours despite differing triage models. Triage was delivered by trained non-clinical call handlers with input from clinical advisors as needed in the first study [52], whereas triage was delivered by nurses or paramedics in the second study [48]. Both models used decision support tools and both studies were based on regional-level data. However, it is not possible to draw any strong conclusions given the lack of adjustment for confounders and the very low certainty of evidence.

3.7.2.1.3.1.4 Within 3 days of using general triage services

One study reported very low-certainty evidence on the accuracy of a remote general triage service compared with face-to-face assessments within 3 days of using the general triage service [50]. A summary of the evidence is presented in Table 28.

This study (comprising 1,089 calls) included calls that were triaged to non-emergency care after calling a general triage service in emergency medical dispatch centres in two counties in Sweden [50]. Calls were triaged by nurses who used a clinical decision support system in 69.8% of calls. Of note, the analysis of this outcome is not based on the use of the clinical decision support system. Non-emergency care in this case meant that patients were triaged to below the need for an ambulance or taking alternate transport to the ED. Callers who were triaged to non-emergency care but who presented to the ED and were judged to need ED treatment at specialist level or to need 'specialist interventions' (i.e. the provision of care above the primary level) were deemed to be undertriaged for the purposes of this review. An undertriage rate of 10.6% (n=116 out of 1,089 calls) was reported in this study based on those who presented to the ED and were judged to need care above the primary level. This rate is not adjusted for confounders, but the authors did provide logistic regression sensitivity analysis in graph form (adjusting for sex, age, weekday call, daytime call, prior contact, county, decision support used, and onward referral) which indicated that those aged 65 years and over were more likely to need specialist intervention within 3 days of triage decision [50] (no statistics were extractable; a graph illustrated the line of significance only).

Spangler *et al.* reported significant data linkage issues, with data missing for 35.8% of calls; this was either due to missing personal identification numbers (33.7%; n=571 out of 1,696 calls) or to data entry issues (2.1%; n=36 out of 1,696 calls) [50]. There was 62.5% agreement by two raters on whether specialist care had been administered or not ((for the entire 7-day follow-up period))(alpha=0.7). Five of seven disagreements between the raters regarding the care level provided resulted from a difference in opinion on whether standard panel blood tests should be classified as specialist care [50]. Overall, the certainty of the evidence was very low.

Table 28 Summary of evidence on accuracy outcomes for remote general triage services compared with face-to-face assessment within 3 days

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Undertriage rate (%)
Accuracy based on face-to-face assessment at the ED within 3-days Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Calls triaged to non-emergency care (n=1,089 calls)	Surveillance system	High	Very low	10.6% triaged below ambulance and ED

3.7.2.1.3.1.5 Within 7 days of using general triage services

Two studies reported very low-certainty evidence on the accuracy of remote general triage services compared with face-to-face assessments within 7 days of using general triage services [42,50]. A summary of the evidence is presented in Table 29.

Table 29 Summary of evidence on accuracy outcomes for remote general triage services compared with face-to-face assessment within 7 days

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Undertriage rate (%)
Accuracy based on face-to-face assessment at ED within 7-days Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Calls triaged to non-emergency care (n=1,089 calls)	Surveillance system	High	Very low	13.1% triaged below ambulance and ED
Accuracy based on face-to-face assessment at ED within 7-days Hodgins *et al.* (2022) [42]	• Call an ambulance • Self-transport to ED • GP house visit within 1-hour • GP house visit within 2-hours • Primary care out-of-hours (PCOOH) appointment within 1-hour • PCOOH appointment within 2-hours • PCOOH appointment within 4-hours • GP house visit within 4-hours • Scheduled appointment • Self-care	All calls by young adults aged 15–34 years with chest pain (n=97,619 callers)	Surveillance system	High	Very low	2.4% triaged below ambulance and ED

The first study (comprising 1,089 calls) included calls that were triaged to non-emergency care after calling a general triage service in emergency medical dispatch centres in two counties in Sweden [50].

Calls were triaged by nurses who used a clinical decision support system in 69.8% of calls. Non-emergency care in this case meant that patients were triaged to below the need for an ambulance or taking alternate transport to the ED. Callers who were triaged to non-emergency care but who presented to the ED and were judged to need ED treatment at specialist level or to need 'specialist interventions' (i.e. the provision of care above the primary level) were deemed to be undertriaged for the purposes of this review. An undertriage rate of 13.1% (n=143 out of 1,089 calls) was reported in this study based on those who presented to the ED and were judged to need care above the primary level. This rate is not adjusted for confounders, but the authors did provide logistic regression sensitivity analysis in graph form (adjusting for sex, age, weekday call, daytime call, prior contact, county, decision support used, and onward referral) which indicated that those aged 65 years and over were more likely to need specialist intervention within 7 days of triage decision [50] (no statistics were extractable; a graph illustrated the line of significance only).

Spangler *et al.* reported significant data linkage issues, with data missing for 35.8% of calls; this was either due to missing personal identification numbers (33.7%; n=571 out of 1,696 calls) or to data entry issues (2.1%; n=36 out of 1,696 calls) [50]. There was 62.5% agreement by two raters on whether specialist care had been administered or not (alpha=0.7). Five of seven disagreements between the raters regarding the care level provided resulted from a difference in opinion on whether standard panel blood tests should be classified as specialist care [50]. Overall, the certainty of the evidence was very low.

The second study (n=97,619 callers) analysed data on continuous urgent care pathways for young adults with chest pain calling NHS 24 over a 3-year period [42]. For the purposes of this review, undertriage was defined as calls that were triaged to below the need for an ambulance or presentation to the ED but were assessed in hospital upon presentation as having a condition 'requiring urgent treatment'. Of the callers who presented to the ED 'requiring urgent treatment' the most frequently assigned International Classification of Diseases, Tenth Revision (ICD-10) code was 'asthma, unspecified' (21.2%; n=653 out of 3,080 callers), while acute myocardial infarction was diagnosed in 0.1% of callers and cardiac arrhythmia was diagnosed in 0.4% of callers. The undertriage rate were 2.4% (n=1,887 out of 79,770 callers) for all those triaged to below the need for an ambulance or presentation to the ED (i.e. callers who were not instructed to call an ambulance or to self-transport to the ED) and 1.1% (n=277 out of 26,151 callers) for those triaged to the least urgent level of care in the form of a scheduled appointment or self-care only (i.e. callers who were not triaged to receive care (e.g. ambulance, ED, GP home visit, PCOOH appointment) within 4 hours). The rate at which urgent treatment was judged to be required for each individual triage disposition category and univariate and adjusted odds ratios are presented in Table 30. Compared with self-care, all other triage dispositions had significantly higher admission rates, suggesting good accuracy for triaging more urgent callers above the self-care level [42].

Table 30 Undertriage rate by triage disposition for all callers within 7 days of using general triage services in Hodgins et al. (2022)

	Triage disposition	Undertriage rate (%)	Number of undertriaged callers	Number of callers	OR (95% CI)	Adjusted OR (95% CI)
Urgent care (i.e. within 4 hours)	Call an ambulance	7.0	821	11,758	23.4 (15.6–34.4)	23.9 (16.2–35.4)
	Self-transport to ED	4.4	267	6,091	14.3 (9.6–21.3)	14.7 (9.8–22.1)
	GP house visit within 1-hour	13.1	17	130	46.9 (24.9–88.6)	48.3 (25.5–91.6)
	GP house visit within 2-hours	10.8	54	498	37.9 (23.7–60.8)	39.5 (24.5–63.6)
	Primary care out-of-hours (PCOOH) appointment within 1-hour	5.9	338	5,697	19.7 (13.3–29.2)	20.3 (13.6–30.4)
	PCOOH appointment within 2-hours	5.1	426	8,390	16.7 (11.3–24.7)	17.3 (11.7–25.8)
	PCOOH appointment within 4-hours	1.9	735	37,976	6.2 (4.2–9.1)	6.4 (4.3–9.5)
	GP house visit within 4-hours	4.3	40	928	14.1 (8.6–23.0)	14.4 (8.7–23.7)
Non-urgent care	Scheduled appointment	1.4	250	17,698	4.5 (3.0–6.7)	4.6 (3.1–6.9)
	Self-care	0.3	27	8,453	Reference	Reference

Source: Hodgins *et al.,* 2022 [42]

Urgent treatment requirement by triage disposition was adjusted for sex, age, remoteness (driving distance), and level of deprivation [42]. Overall, weak but statistically significant associations were reported between odds of requiring urgent care and being female (OR: 1.1; 95% CI: 1.0–1.2) and socioeconomic deprivation from Levels 2 to 4 (e.g. Level 4: OR: 1.2; 95% CI: 1.02–1.4) compared with Level 1 or the highest level of deprivation. Age and remoteness were not significant. Triage disposition data were missing for 5.1% of callers (n=5,203 out of 102,822 callers) [42]. Overall, the evidence was of very low certainty.

3.7.2.1.3.2 Accuracy: Remote triage assessment compared with final diagnosis

Two studies provided very low-certainty evidence on the accuracy of out-of-hours primary care services in the Netherlands compared with the final diagnosis [45,46]. A summary of the evidence is presented in Table 31.

Table 31 Summary of evidence on accuracy outcomes of out-of-hours primary care triage systems compared with final diagnosis

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Missed cases (%)
Final diagnosis of transient ischaemic attack/stroke Engelen (2023) [45]	High urgency: • U1: life-threatening (ambulance within 15 minutes) • U2: emergent (appointment at out-of-hours services in primary care (OHS-PC) or GP home visit within 1-hour) Low urgency: • U3: urgent (appointment at OHS-PC or GP home visit within 3-hours) • U4: non-urgent (appointment at OHS-PC or telephone advice within 24-hours) • U5: advice (telephone advice)	Calls with transient ischaemic attack or stroke symptoms (n=1,955 calls)	Surveillance system	High	Very low	26.5% overall No significant difference in accuracy when nurses overruled the urgency allocated by the Netherlands Triage Standard tool
Final diagnosis of acute coronary artery syndrome Leclair (2023) [46]	As in cell above	Calls with acute coronary artery syndrome symptoms (n=2,195 calls)	Surveillance system	High	Very low	21.5% overall GP consultation significantly lowered sensitivity (31% missed)

Both of the included studies are based on calls to nine out-of-hours primary care services based in the vicinity of the city of Utrecht and were part of the Safety First study [55]. Callers were triaged by a nurse who used a semi-automatic tool known as the Netherlands Triage Standard, which the triageur can overrule. The triage nurse had an option to consult with a GP when required [55].

The first study (comprising 1,955 calls reporting transient ischaemic attack or stroke symptoms) assessed triage urgency level based on a final diagnosis of transient ischaemic attack or stroke [45]. A high urgency level (U1–U2: ambulance, GP home visit, or appointment at out-of-hours services in primary care (OHS-PC) within 1 hour) was deemed adequate or accurate for transient ischaemic attack or stroke, while being triaged to a low urgency level (U3–U5: appointment within 3 hours or 24 hours, or advice only) was deemed inadequate [45].

The accuracy of the urgency attributed by the Netherlands Triage Standard decision support tool alone was analysed, as well as the final urgency attributed where nurses opted to overrule the Netherlands Triage Standard tool (18.8% overall and 17.6% within actual confirmed cases of transient ischaemic attack or stroke, meaning that the rate of overrule was similar in true cases and in the overall sample) [45]. No analysis of the role of GP consultation was conducted, and it was unknown from the paper in how many calls a GP consultation occurred. Pooling all calls, overall sensitivity for appropriately triaging 732 actual cases of transient ischaemic attack or stroke was 73%, with 27% of true cases being missed. The Netherlands Triage Standard-assigned triage level without overrule (81% of all calls; n=1,587 out of 1,955 calls) had moderate to low accuracy with a sensitivity of 0.69 (69% identified and 31% missed), a specificity of 45%, a positive predictive value (PPV) of 59%, and a negative predictive value (NPV) of 56% [45]. The final triage urgency level in cases where nurses overruled the Netherlands Triage Standard (18.8% of calls, or 368 out of 1,955 calls) also had moderate to low accuracy, with a sensitivity of 76% and 24% of true cases being missed, a specificity of 38%, a PPV of 58%, and an NPV of 58% [45]. Although sensitivity appeared to be a little higher where nurses overruled the Netherlands Triage Standard tool, this appeared to come at the cost of effectiveness given the decrease in specificity, meaning that more patients without transient ischaemic attack or stroke were being triaged to a high urgency. In summary, among calls where nurses did not overrule the Netherlands Triage Standard, 55% of patients who did not have transient ischaemic attack or stroke were triaged as high urgency unnecessarily, compared with 62% of calls when nurses did overrule the tool. Overruling had little effect on the PPV and NPV [45]. Table 32 provides a summary of the accuracy of triage for all calls, as well as specific to calls triaged using the Netherlands Triage Standard tool and calls where the tool was overruled by the triage nurse. Based on logistic regression analyses, however, there was no significant difference in accuracy when nurses overruled the urgency allocated by the Netherlands Triage Standard tool (OR: 0.99; 95% CI: 0.75–1.31; p=0.970). This was also true when adjusted for age (adjusted OR: 0.89; 95% CI: 0.66–1.20; p=0.43) and stratified by sex with and without age adjustment. At least 39.5% of calls were excluded due to missing final diagnosis data (n=1,435 calls out of 3,630), with the number excluded due to GP refusal to participate unreported. The evidence was of very low certainty.

Table 32 Summary of evidence on accuracy outcomes of out-of-hours primary care triage system for transient ischaemic attack or stroke

	Calls	Caught (sensitivity/true positives)	Missed cases (false negatives)	False positives
All calls (including overruled calls and those with GP consultation where occured)	1,955	73%	27%	Not reported
Calls decided by the Netherlands Triage Standard tool	1,587	69%	31%	55%
Calls overruled by the nurse	368	76%	24%	62%

Source: Engelen, 2023 [45]

The second study (comprising 2,195 calls with symptoms of acute coronary artery syndrome) assessed triage urgency level based on a final diagnosis of acute coronary artery syndrome. In the same service and stemming from the same source study as that used by Engelen (2023) [55], Leclair examined the accuracy of triage urgency allocated based on a final diagnosis of acute coronary artery syndrome using the same high (U1–U2) and low (U3–U5) or adequate and inadequate urgency levels.

Overall, the sensitivity for acute coronary artery syndrome was 78.5% (n=197 out of 251 calls), with 21.5% (n=54 out of 251 calls) of true cases being missed (i.e. triaged to low urgency) (Table 33). In addition to overall sensitivity, triage urgency was assessed for accuracy based on whether or not nurses consulted a GP. GP consultation significantly lowered sensitivity to 69%, with 31% of callers who were diagnosed with acute coronary artery syndrome being missed (OR: 0.32; 95% CI: 0.17–0.61).

Triage urgency was also assessed for accuracy based on whether or not nurses opted to overrule the Netherlands Triage Standard tool. Where the nurses did not overrule the Netherlands Triage Standard tool, sensitivity was 73%, while for cases where a GP was consulted and there was no overruling, sensitivity was 61%. Overall, sensitivity was highest (87%) for cases without GP consultation (with or without overrule). Sensitivity was lowest (61%) for cases with GP consultation and without overrule.

In relation to confounding variables, age and sex were adjusted for in the analysis of accuracy based on whether or not nurses consulted a GP. For female callers, the effect of GP consultation on reduced accuracy of triage was stronger (OR: 0.24; 95% CI: 0.08–0.69), while adjustment for age had no impact overall or within sex (adjusted OR for women adjusted for age (per year): 0.26 (95% CI: 0.09–0.78)). There was no adjustment for confounders on the overrule outcome in this study. For 2 out of 1,955 calls data were missing on whether overruling had occurred or not. The author also reported that 29.6% of the random subsample of calls were excluded as they were missing final diagnosis data but is unknown what number of calls this represented as the author did not report the size of the random subsample taken. Overall, the evidence was of very low certainty.

Table 33 Summary of evidence on accuracy outcomes of out-of-hours primary care triage system

	Caught (sensitivity/true positives)	Missed cases (false negatives)
Overall (including GP consultation and overrule as occurred)	78%	22%
GP consulted (including overrule as occurred)	69%	31%
No GP consulted (including overrule as occurred)	87%	13%
Without overruling (including GP consultation as occurred)	73%	27%
GP consulted and no overrule	61%	39%
No GP consulted and no overrule	83%	17%

Source: Leclair, 2023 [46]

3.7.2.1.3.2.1 Subgroup comparisons for final diagnosis

In summary, in the first study [45], overall sensitivity for calls with a final diagnosis of transient ischaemic attack or stroke was 73%, meaning that 27% of true transient ischaemic attack or stroke cases were missed. In the second study, overall sensitivity for calls with a final diagnosis of acute coronary artery syndrome was 78%, meaning that 22% of cases were missed [46]. There is very low-certainty evidence to suggest that a high proportion of acute coronary artery syndrome and transient ischaemic attack or stroke cases were not identified through remote triage. However, as no meta-analysis was possible, strong conclusions based on this comparison cannot be drawn.

3.7.2.1.3.3 Accuracy: Remote triage assessment based on serious adverse events

One study provided very low-certainty evidence on serious adverse events (death or need for organ support) in a remote general triage service [43]. A summary of the evidence is presented in Table 34.

Table 34 Summary of evidence on accuracy of general triage services based on serious adverse event outcomes

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Missed cases (%)
Accuracy based on serious adverse events (mortality/organ failure) Marincowitz *et al.* (2022) [43]	• Ambulance dispatch/urgent clinical assessment • Self-care/non-urgent assessment	Unique callers to a general triage line in the Yorkshire region who reported symptoms of COVID-19 (n=40,261 unique patients)	Surveillance system	High	Very low	19% at 3 days 25.6% at 7 days 25.8% at 30 days (14% at 30 days with addition of smell and taste symptoms)

Marincowitz *et al*. identified 40,261 unique adult callers from 58,764 calls (with COVID-19-related triage dispositions and a verified NHS number) by excluding 76 calls that could not be linked to the callers' medical records, 6,222 calls which were repeat calls, 11,912 calls which were from or about individuals aged 15 years and under, and 313 calls which were missing a triage disposition. For reasons not presented in the paper, there was an additional discrepancy of 896 participants between adding up each triage disposition separately and using the overall numbers provided; Marincowitz *et al*. do not explain

how this discrepancy arose. The study examined data for the 40,261 unique adult callers to a general triage line in the Yorkshire region who reported symptoms of COVID-19 [43]. Triage was conducted by a trained non-clinical call advisor in the first instance with the option to pass the call on to a nurse, paramedic, or other specialist clinician for further assessment. The NHS Pathways clinical decision support software, as locally implemented in the Yorkshire Ambulance Service NHS Trust, was used. In phase 2 of the study, additional symptoms related to taste and smell were added. Specific safety outcomes defined as serious adverse events (a composite outcome representing death or the need for organ support (renal, respiratory, or cardiovascular)) were assessed at 3-, 7-, and 30-day follow-up time points (Table 35) [43].

For each follow-up period, sensitivity, specificity, PPVs, and NPVs were reported based on whether patients had been triaged to ambulance dispatch for urgent clinical assessment (n=15,030) or to self-care for non-urgent assessment (n=24,335) [43]. Multiple calls from single patients were excluded, with the analysis being based on the triage disposition assigned on first contact [43].

Overall sensitivity was 74.2%, with higher sensitivity reported for shorter follow-up time points: 74.4% at 7 days and 81.4% at 3 days [43]. Further analysis was conducted in order to confirm that results were similar where triage disposition was taken from the last contact (77.3%) rather than the first contact and to assess the difference a change in included symptoms made. In phase 2 of the study when loss of taste and smell were added as symptoms, sensitivity at 30 days increased to 85.7%; however, specificity decreased from 61.5% to 51.5%, meaning that 48.5% of those who did not go on to experience serious adverse event outcomes were triaged to ambulance or urgent clinical assessment [43].

Overall, for the entire study period, the false positive rate (i.e. those triaged to ambulance or urgent assessment who did not experience serious adverse events (mortality or the need for organ support)) was 38.5% [43].

While CIs were included, it should be noted that the sensitivity, specificity, PPV, and NPV rates presented in Table 35 are unadjusted [43]. Separately, multivariate modelling was done to predict false negative (n=310) and false positive (n=10,000) status at 30 days [43].

Risk factors explored were age (per 1-year increase), gender, defined comorbidities (cardiovascular disease, chronic respiratory disease, diabetes, hypertension, immunosuppression (including steroid use), active malignancy, obesity, renal impairment, being a smoker (interpreted as tobacco use and dependence), and stroke), number of medications used (0, 1–5, 6–10, and 11 or more), socioeconomic status (i.e. deprivation index (based on postcode) scores of 1–2, 3–4, 5–6, 7–8, and 9–10), and number of NHS 111 calls made during the study period (1, 2, or 3 or more) [43]. Younger age, diabetes, and multiple NHS 111 calls were associated with increased risk of false negative status (i.e. an increased risk among those with COVID-19, of being triaged to self-care or non-urgent care but dying or requiring organ support within 30 days). The effect of multiple NHS 111 calls was similar regardless of whether undertriage was defined based on the triage disposition assigned at the first or last call [43].

Chronic renal impairment, immunosuppression, chronic respiratory disease, older age, smoking, being female, and increased medication use were all associated with an increased risk of false positive status (i.e. an increased risk, among those without the outcome (dying or needing organ support within 30 days), of being dispatched an ambulance or directed to urgent care [43]. The evidence was of very low certainty.

Table 35 Serious adverse events (death/need for organ support) at 3, 7, and 30 days follow-up from use of general triage services

	Proportion of sample with outcome	Sensitivity	Specificity	PPV	NPV
30 days overall	3.0% (95% CI: 2.8–3.2%) (1,200 out of 40,261 calls)	74.2% (95% CI: 71.6–76.6)	61.5% (95% CI: 61–62%) (38.5% false positive rate)	5.6% (95% CI: 5.2–6%)	98.7% (95% CI: 98.6–98.9%)
30 days (sensitivity analysis based on last call instead of first call)	Not reported	77.3% (95% CI: 74.8–79.6)	Not reported	Not reported	98.9% (95% CI: 98.7–99%)
30 days (sensitivity analysis based on first phase)	3.1% (95% CI: 2.9–3.2%) (1,103 out of 36,124 calls)	73.2% (95% CI: 70.4–75.7)	62.7% (95% CI: 62.1–63.2%) (37.3% false positive rate)	5.8% (95% CI: 5.4–6.2%)	98.7% (95% CI: 98.5–98.8%)
30 days (sensitivity analysis based on second phase (after loss of smell and taste were included as symptoms))	2.4% (95% CI: 1.9–2.9%) (98 out of 4,137 calls)	85.7% (95% CI: 76.9–91.7)	51.5% (95% CI: 50–53.1%) (48.5% false positive rate)	4.1% (95% CI: 3.3–5.1%)	99.3% (95% CI: 98.9–99.6%)
7 days overall	1.7% (95% CI: 1.6–1.8%) (670 out of 40,261 calls)	74.4% (95% CI: 70.9–77.6)	61% (95% CI: 60.5–61.5%) (39% false positive rate)	3.1% (95% CI: 2.9–3.4%)	99.3% (95% CI: 99.2–99.4%)
3 days overall	0.8% (95% CI: 0.7–0.9%) (320 out of 40,261 calls)	81.4% (95% CI: 76.6–85.5)	60.8% (95% CI: 60.2–61.3%) (39.2% false positive rate)	1.6% (95% CI: 1.4–1.8%)	99.8% (95% CI: 99.7–99.9%)

Source: Marincowitz *et al.* 2022 [43]

3.7.2.1.3.4 Accuracy: Remote triage assessment based on a validated tool

One study provided very low-certainty evidence on the accuracy of a general triage service based on assessment using a validated tool [47]. A summary of the evidence is presented in Table 36.

This study examined the accuracy of two Danish out-of-hours primary care services – one employing a GP-led triage model and the other employing a nurse-led triage model (with a computerised decision support system guiding triage) – by evaluating 806 randomly selected general calls and 405 high-risk calls (individuals aged 30 years and over seeking assistance for abdominal pain) [47]. In addition to the decision support system, the nurse-led triage service also had the option to redirect calls to an on-call physician as needed. In order to enable a clear comparison, for calls that triage nurses redirected to a physician, only the portion of the call conducted by the nurse was available for assessment, and calls could be assessed as optimal if the decision to redirect the call was what would be expected [47].

Accuracy was assessed using the validated Assessment of Quality in Telephone Triage tool [47]. A single Assessment of Quality in Telephone Triage item using a 7-point scale to differentiate between levels of undertriage (ratings of 1–3), optimal triage (a rating of 4), and overtriage (ratings of 5–7) was used by 24 experienced physicians who were active in telephone triage and had completed a 2-day training course. Condensing the 7 points in order to create dichotomous scales for clinically relevant undertriage (ratings of 1 and 2 compared with ratings of 3–7) and clinically relevant overtriage (ratings of 6 and 7 compared with ratings of 1–5) revealed satisfactory interrater agreement in the assessment of accuracy. Assessors were blinded to both the type of call and the triage model used [47,56].

In relation to the random sample of general callers, 5.5% (n=44 out of 806 calls) were considered to be clinically relevant cases of undertriage (1.5% were severe undertriage and 4.0% were moderate undertriage) [47]. Univariate risk ratios for potential confounders in terms of call characteristics (weekend or not, time of day) and age and sex were examined individually in relation to clinically relevant undertriage, but all were non-significant [47].

In relation to the subgroup of high-risk callers aged 30 years and over reporting abdominal pain, 7.9% (n=32 out of 405 calls) were considered to be clinically relevant cases of undertriage (3.0% were severe undertriage and 4.9% were moderate undertriage) [47]. Univariate risk ratios for potential confounders in terms of call characteristics (weekend or not, time of day, GP-led model, or nurse-led model) and age and sex were examined individually in relation to clinically relevant undertriage. Night-time calls were more likely to be undertriaged than daytime/evening calls (relative risk: 2.1; 95% CI: 1.05–4.07), and calls to the nurse-led triage service were less likely to be undertriaged (relative risk: 0.47; 95% CI: 0.23–0.97) compared with calls to the GP-led service. The rate of clinically relevant undertriage was 5.0% for the nurse-led service (n=10 out of 199 calls) and 10.7% for the GP-led service (n=22 out of 206 calls) [47].

Table 36 Summary of evidence on accuracy of a general triage service based on assessment with a validated tool

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Clinically relevant undertriage (%)
Accuracy based on a validated tool Graversen *et al.* (2023) [47]	Not reported	A random sample of general calls (n=806), and a specific subgroup (individuals aged 30 years or over seeking assistance for abdominal pain) identified as high-risk calls (n=405)	Surveillance system	High	Very low	General calls 5.5% (Nurse-led triage compared with GP-led triage was not examined for general calls) High risk calls i.e. abdominal pain aged 30 and over 7.9% (For high-risk calls, nurse-led triage had a significantly lower rate of clinically relevant undertriage (5.0% compared with GP-led triage (10.7%))

3.7.2.2 Effectiveness

Ten studies assessed the effectiveness of remote general triage services (Table 6). The effectiveness outcomes assessed were triage disposition (nine studies), ED attendance (four studies), overtriage rates (two studies), case resolution rates (one study), and healthcare utilisation (two studies).

3.7.2.2.1 Triage disposition

Nine primary studies reported very low-certainty evidence on triage disposition in remote general triage services [42–46,48–50,52]. A summary of the evidence on triage disposition outcomes is provided in Table 37. Generally, triage dispositions range from high urgency (e.g. ambulance and self-present to ED), down to moderate urgency (e.g. a PCOOH appointment), and finally down to low urgency (e.g. self-care, attend a GP, or make a scheduled primary care appointment). In this review we use the term ED avoidance to refer to cases where the triage service or triageur was able to direct to a triage disposition below ED, such as advice to attend GP, self-care, or other follow-up outside of ED (with range of options available depending on triage service and local healthcare system). Thus, ED avoidance here does not refer to patient intentions or compliance but solely to the triage disposition assigned by the service.

The first study analysed data from a general triage service, NHS 24 in Scotland, focusing on 97,619 calls from young adults (aged 15–34 years) with chest pain [42]. The study reported that 25.4% of the callers were triaged to low-urgency disposition. Within the low-urgency disposition, 17.2% of callers were advised to attend an in-hours scheduled appointment the next working day, and 8.2% of callers were advised to self-care. The triage disposition of a GP home visit or a PCOOH appointment was the most commonly recommended service, with 52.1% of calls ending with this advice (1.5% for GP home visits and 50.6% for PCOOH appointments). For high-urgency triage dispositions, this study reported that 5.9% of callers were advised to self-transport to the ED, and 11.4% of callers were advised to call an emergency ambulance. All triage disposition data grouped together suggest that the ED avoidance rate was 82.7%. There were missing data for 5.1% of triage dispositions in this study cohort. There was no adjustment for confounders [42] and the certainty of the evidence was very low.

The authors of the second study identified 40,261 unique adult callers from 58,764 calls (with COVID-19-related triage dispositions and a verified NHS number) by excluding 76 calls that could not be linked to the callers' medical records, 6,222 calls which were repeat calls, 11,912 calls which were from or about individuals aged 15 years and under, and 313 calls which were missing a triage disposition. For reasons not presented in the paper, there was an additional discrepancy of 896 participants between adding up each triage disposition separately and using the overall numbers provided; Marincowitz *et al*. do not explain how this discrepancy arose. This study examined data for the 40,261 unique adult callers to a general triage line in the Yorkshire region who reported symptoms of COVID-19 [43]. The authors reported the triage dispositions by dividing them into two groups: urgent advice (39.6%) and non-urgent advice (60.4%). Of the urgent advice dispositions, 9.8% of all unique callers required an ambulance response, 27.9% required an urgent follow-up COVID-19 assessment, and 1.4% required urgent follow-up by a GP (we note that these reported subpercentages summed to 39.1% rather than 39.6% assigned urgent advice as reported and this was not explained by the authors). Of the 24,335 non-urgent advice dispositions, 32.1% of all unique callers were advised to self-care, 26.1% were given non-urgent COVID-19 assessment dispositions, and 2.2% required a non-urgent GP assessment. Including all triage dispositions below ambulance response and urgent clinical assessment, we calculate a maximum potential ED avoidance rate of 61.8% [43]. The authors of this study defined the triage disposition of urgent follow-up clinical assessment as including advice to self-present to the ED, or provision of a further clinical assessment either immediately or within 4 hours of the call [43]. There was no adjustment for confounders, and the certainty of the evidence was very low [43].

The third study assessed calls from 29,673 unique callers aged 36 years and over with chest pain recorded as the reason for their call [44]. The study reported that the majority of calls ended with a recommendation of an appointment (75% for physician-directed calls and 65% for nurse-directed calls). Overall, the authors reported that 87% of patients were ultimately directed to services outside of the ED (or an ED avoidance rate of 87%). Physician-directed calls gave ED referral advice to 10% of callers, whereas nurse-directed calls gave ED referrals to 16% of callers. Based on adjusted logistic regression analysis, the odds of physicians compared with nurses directing callers to the ED was 41% lower (adjusted OR: 0.59 (95% CI: 0.55–0.64)). Propensity matching on patient characteristics (age, sex, race/ethnicity, comorbidities, ED co-payment terms, a visit to ED/hospital/office in last 12 months and call centre utilisation in past 12 months) and call characteristics (particular call centre, time of call, month of call) was used in order to control for confounders [44]. Repeat callers (18.0%, n=7,058 out of 39,197 callers) and calls with data that could not be linked (6.3%, n=2,466 out of 39,197 calls) were excluded from the analysis. Pregnant women (n=119), non-English-language callers (n=8,115), callers who had upper respiratory infection complaints or who were trauma victims (n=241) were also excluded from the research [44]. Overall, the evidence was of very low certainty.

The fourth study examined 103,768 patients who were initially deemed low acuity (non-urgent) by the Australian emergency telephone number and passed onto the referral telephone triage service [48]. The researchers followed all patients who underwent referral service triage and presented to the ED within 48 hours of their call. In total, 69.5% (n=72,141) of calls were directed to the ED and 30.5% (n=31,627) were directed to the alternative care pathways. The particular triage disposition breakdown of calls directed to the ED (as a proportion of all calls) was 28.5% in an emergency ambulance, 19.1% in a non-emergency ambulance, and 21.9% by self-presenting to the ED. Among all calls, 11.0% were directed to an alternative service and 19.2% were given self-care advice. Overall, this study found the ED avoidance rate for low-acuity callers to be 30.5% [48]. There was no adjustment for confounders and the certainty of the evidence was very low.

The fifth study investigated calls from 4,962 unique non-urgent, Level E patients (triaged to below ambulance dispatch) [49]. However, particular triage disposition status within this sample known to be triaged to below ambulance was missing for 556 patients, and analysis for triage disposition is therefore based on only 4,406 Level E patients. Analysis was based on the first call to the triage service by unique patients, with repeat calls excluded. Among all callers, 17.9% were directed to the ED, 63.2% were directed to the GP, 10.3% were directed to other services, and 8.6% were provided with advice only. Overall, the ED avoidance rate among Level E patients was 82.1%. The triage disposition data were, as above, missing for 11.2% of unique callers, and 47.2% of callers were excluded because their triage data could not be linked with their medical record [49]. There was no adjustment for confounders and the evidence was of very low certainty.

The sixth study analysed 3,614,915 calls to NHS 111 in the Yorkshire and Humber regions in the UK over a 4-year period [52]. The authors included 3,631,069 calls comprising every triage disposition, with only 0.4% (n=16,154) of calls missing data. Accounting for this missing data, the breakdown of triage dispositions for all calls was as follows: 11.6% of calls were transferred for ambulance dispatch; 6.7% of calls were advised to attend the ED; 61.2% of calls were advised to attend primary or community care; 5.2% of calls were advised to attend another service; and 15.4% of calls were advised to self-care. Overall, the data indicate an ED avoidance rate of 81.8%. Subgroup analysis comparing triage by a clinical advisor with triage by a non-clinical call handler indicated that clinical advisors were more likely to recommend self-care (approximately 28% compared with 10% of calls handled by non-clinical call handlers alone) and directed fewer callers to primary care/community services than non-clinical call handlers (approximately 50% of calls involving a clinical advisor compared with 62% of calls handled by a non-clinical call handler

alone). The authors noted that this may be due to clinical advisors' greater confidence in their ability to recognise minor health issues. There was little difference between clinical advisors and non-clinical call handlers in terms of the proportion of calls directed to attend the ED (approximately 9% of calls involving a clincal advisor compared with 5% of those handled by a non-clinical call handler alone) and transferred for ambulance dispatch (approximately 9% of calls involving a clincal advisor compared with 10% of those handled by a non-clinical call handler alone). Additionally, subgroup analysis compared different age groups and reported that older patients received fewer primary care triage dispositions (48% of callers aged 75 years and over compared with 65% of callers aged 16–44 years) and self-care triage dispositions (11% of callers aged 75 years and over compared with 18% of callers aged 16–44 years). Conversely, older patients were more often sent an ambulance (20% of callers aged 75 years and over compared with 7% of callers aged 16–44 years) or directed to other services (17% of callers aged 75 years and over compared with 2% of callers aged 16–44 years), while being less likely to be advised to self-present to the ED (3% of callers aged 75 years and over compared with 10% of callers aged 16–44 years) [52]. The certainty of the evidence was very low.

The seventh study investigated 1,089 calls that were triaged to non-emergency care by emergency medical dispatch centres in two counties in Sweden [50]. A total of 47.7% of calls were closed pending re-contact (self-care) and the remainder were triaged to a mobile geriatric team; referred to an advice line, ambulette (an ambulance used to transport patients who are not seriously ill), other transport, poison control; or given another referral. Given the restriction of this study to calls triaged to below the need to attend the ED, the ED avoidance rate was 100%. There were significant data linkage issues, with data missing for 35.8% of calls (n=607 out of 1,696). The rates at which calls were triaged to various dispositions were not adjusted for confounders; however, the authors did comment on differences between non-emergency patients compared with all patients contacting the two centres. Patients with non-emergency dispositions were younger (median age: 57 years) when compared with the complete population (median age: 69 years) and contacted the emergency dispatch centre more often (14% were frequent callers) compared with the population of all patients (4% were frequent callers). A lower percentage of calls also occurred during the daytime among non-emergency triage dispositions (48% compared with 59%). The clinical decision support system was used less frequently for callers referred to non-emergency care (60% compared with 84%). The proportion of patients with a missing or invalid personal identification number was also higher among patients referred to non-emergency care (30% compared with 9%) [50]. The certainty of the evidence was very low.

The eighth study examined 1,955 calls from patients with suspected symptoms of transient ischaemic attack or stroke across 9 out-of-hours primary care services in the Netherlands [45]. Nurses conducted triage using the Netherlands Triage Standard decision support tool and could consult with supervising GPs as needed. Nurses could also overrule the decision support tool. The breakdown of triage dispositions was reported for all calls, as well as separately for calls where nurses did (n=368 out of 1,955 calls; 18.8%) and did not (n=1,585 out of 1,955 calls; 81.1%) opt to overrule the urgency attributed by the Netherlands Triage Standard decision support tool. The study reported that the only triage disposition option for referral to the ED was ambulance, and 29.7% of all calls were assigned this triage disposition. Therefore, while the majority of calls were referred to below ambulance disposition (or an ED avoidance rate of 70.3%), this included 42.2% of calls which were triaged to an urgent appointment at an out-of-hours service in primary care (OHS-PC) or a GP home visit (this 42.2% comprised 32.7% within 1 hour and 9.5% within 3 hours). The remaining 28.1% of calls were triaged to telephone advice and less urgent appointments occurring within 24 hours [45].

The ED avoidance rate was similar for calls where the decision support system's triage disposition was accepted (68.9%) and for calls where the decision support system was overruled (76.1%) [45]. A higher

proportion of calls were triaged to urgent appointments within 1 or 3 hours (48.8%) where the decision support system's triage disposition was accepted compared with calls where the decision support system was overruled (13.6%). Where the decision support system was overruled, the majority (60.3%) of calls were triaged to telephone advice only with no time conditions. Finally, the ED avoidance rate for calls where the decision support system was not overruled was 68.9%, with a large proportion (48.8%) triaged to an urgent appointment within 1 (38.5%) or 3 (10.3%) hours [45].

For transient ischaemic attack or stroke, a high urgency level (U1–U2: ambulance; or GP home visit or out-of-hours service in primary care (OHS-PC) appointment within 1 hour) was deemed an adequate response by the authors and a low urgency level (U3–U5: appointment within 3 hours, appointment or advice within 24 hours, or advice only) was deemed an inadequate response [45]. Overall, 62.8% of calls received a high urgency level. The not overruled group were significantly more likely to receive a high urgency level (32.9% of overruled calls compared with 69.7% of not overruled calls; $p<0.001$) and the overruled group were significantly more likely to receive a low urgency level (30.3% of not overruled calls compared with 67.1% of overruled calls; $p<0.001$) [45]. Despite equivalent totals, there were unexplained small discrepancies (for up to 6 calls) present in the paper in relation to the number of calls within each disposition category when fully broken down compared with when grouped into high and low urgency (e.g. 727 low urgency calls overall reported compared with 733 when manually adding up totals for U3 to U5). We have reported the breakdowns provided by the authors where results of significance testing were provided and otherwise provided the full breakdown the author provided for all 5 disposition categories.

Overall, 368 (18.8%) of the 1,955 calls were overruled. Of the overruled calls, 70.0% of the urgency dispositions were overruled towards a higher urgency (predominantly from U5 up to U3 or U2) [45]. Conversely, the remaining 30.0% were downgraded (predominantly from U1 down to U2). Additionally, the authors compared male callers and female callers, and found that males appeared to be upgraded more often than females, but this difference was not statistically significant (71.7% compared with 62.3%; $p=0.996$) [45]. At least 39.5% of calls were excluded due to missing final diagnosis data (n=1,435 calls out of 3,630), with the number excluded due to GP refusal to participate unreported. Overall, the certainty of the evidence was very low.

The ninth study was based on the same out-of-hours primary care services in the Netherlands as the study by Engelen but focused on 2,195 callers with symptoms of acute coronary artery syndrome [46]. This study reported on grouped triage dispositions, where a high-urgency disposition (U1–U2: (ambulance; or GP home visit or out-of-hours service in primary care (OHS-PC) appointment within 1 hour) was deemed adequate and a low-urgency disposition (U3–U5: OHS-PC appointment within 3 hours, appointment or advice within 24 hours, or advice only) was deemed inadequate. Therefore, it was not possible to extract an ED avoidance rate for this study. Overall, 63.0% of all calls were triaged to a high-urgency disposition while 37.0% were triaged to a low-urgency disposition [46].

For 1,148 calls in which the supervising GP was involved, a high urgency was assigned significantly more often (65.6%) than calls where the supervising GP was not involved in triage (60.2%) (OR: 1.26; 95% CI: 1.06–1.50; $p=0.009$) [46]. Adjustment for age and sex did not affect the overall significant OR (OR: 1.26; 95% CI: 1.05–1.51; $p=0.0012$); however, when stratified by sex, this difference was no longer significant in males (63.2% compared with 59.4%; OR: 1.17; 95% CI: 0.91–1.52; $p=0.231$), but remained significant in females (67.6% compared with 60.7%; OR: 1.35; 95% CI: 1.07–1.71; $p=0.012$) [46].

In relation to other confounders, overall there was no difference in the likelihood of GP involvement for calls which turned out to be true cases of acute coronary syndrome (n=251) (OR: 0.79; 95% CI: 0.61–1.03; $p=0.075$) until adjusted for sex and age per year (OR: 0.75; 95% CI: 0.57–0.98; $p=0.034$) [46]. When

stratified by sex, this was only significant for calls by females when also adjusted for age per year (OR: 0.65; 95% CI: 0.42–0.99; *p*=0.043) [46].

In relation to calls which were later diagnosed to be acute coronary artery syndrome or other life-threatening events (aortic dissection and pulmonary embolism) (n=319 calls), again GP involvement was not significantly more likely (OR: 0.79; 95% CI: 0.63–1.01; *p*=0.055) until adjusted by sex (OR: 0.78; 95% CI: 0.61–0.99; *p*=0.040), age per year (OR: 0.76; 95% CI: 0.60–0.98; *p*=0.030), or both (OR: 0.75; 95% CI: 0.59–0.96; *p*=0.021) [46]. Stratification by sex showed that GP involvement was significantly more likely in female callers who ended up being true cases of acute coronary artery syndrome or other life-threatening events, whether age-adjusted (OR: 0.64; 95% CI: 0.44–0.94; *p*=0.021) or not (OR: 0.68; 95% CI: 0.47–0.98; *p*=0.038) [46]. For 2 out of 1,955 calls data were missing on whether overruling had occurred or not. The author also reported that 29.6% of the random subsample of calls were excluded as they were missing final diagnosis data but is unknown what number of calls this represented as the author did not report the size of the random subsample taken. The certainty of the evidence was very low.

3.7.2.2.1.1 Subgroup comparisons for triage disposition

It was possible to calculate ED avoidance rates for eight of the nine studies reporting on triage disposition levels [42–45,48–50,52]. Overall, ED avoidance rates ranged from 30.5% to 100% in the eight studies, but the avoidance calculations included one study that was specific to services which dispatch urgent alternative service providers to patients' homes [48], and another study that was specific to non-serious calls [50]. The remaining six studies reported triaging between 61.8% and 90% of calls below the need for an ambulance or presentation to the ED. Lewis *et al.*, the only study to examine all calls to a general triage service, reported an ED avoidance rate of 81.8%, with 15.4% of callers receiving no recommendation to seek any additional care.

Two papers assessing nine out-of-hours primary care services in the vicinity of the city of Utrecht in the Netherlands examined triage dispositions for calls with symptoms of transient ischaemic attack or stroke [45] and calls for acute coronary artery syndrome [46]. For transient ischaemic attack or stroke symptoms, 62.8% of calls were triaged to a high urgency, compared with 63.0% of calls for symptoms of acute coronary artery syndrome. Overall, both studies reported similar proportions of patients triaged to a high-urgency triage disposition based on symptoms suggestive of differing but potentially serious conditions.

Table 37 Summary of evidence on triage dispositions in general triage services and their outcomes

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Hodgins *et al.* (2022) [42]	NHS 24	All calls by young adults aged 15–34 years with chest pain (n=97,619 callers)	8.2% (advice, no referral)	17.2% (patient to make a scheduled appointment to attend an in-hours service the next working day)	52.1% (GP home visit/PCOOH appointment within 4 hours)	5.9% (self-present to ED)	11.4% (call an emergency ambulance)	High	Very low	82.7%
Marincowitz *et al.* (2022) [43]	NHS 111	Unique callers to a general triage line in the Yorkshire region who reported symptoms of COVID-19 (n=40,261)	32.1%	28.3%: • Non-urgent GP assessment (2.2%) • Further non-urgent COVID-19 assessment (26.1%)	29.3%: • Urgent follow-up COVID-19 clinical assessment (27.9%) (included advice to self-present to ED, but this proportion was not reported) • Urgent follow-up GP assessment (1.4%)		9.8%	High	Very low	61.8%*

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Sax *et al.* (2018) [44]	Appointment and advice call centre of Kaiser Permanente Northern California	Adults aged 36 years and over with chest pain (12,064 physician-directed calls and 17,609 nurse-directed calls prior to propensity matching)	Physician-directed calls: 6%**; nurse-directed calls: 5%** (based on percentage referred outside ED remaining)	Physician-directed calls: 84%**; nurse-directed calls: 79%**: • Appointment recommended (clinic/phone): physician-directed calls: 75%; nurse-directed calls: 65% • Urgent message sent to caller's primary care provider: physician-directed calls: 9%; nurse-directed calls: 14%	N/A	Physician-directed calls: 10% (ED referrals) Nurse-directed calls: 16% (ED referrals)	N/A	High	Very low	Combined (physician- and nurse-directed calls): 87% directed to venues outside ED (physician-directed calls: 90%; nurse-directed calls: 84%)

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Eastwood *et al.* (2017) [48]	Referral service	Callers in metropolitan Melbourne deemed low acuity by the Australian emergency telephone number (n=103,768 calls)	30.5% (urgent follow-up/attend alternate service/self-care): • 11.0% Alternate service providers dispatched' (referred to alternative service providers, including out-of-hours home-visiting doctor services, home-visiting nurses, hospital outreach programmes (that send allied health staff into the community), crisis assessment and treatment teams for psychiatric cases, poisons telephone advice line, and other services that can assist with non-medical issues such as lifting patients) (urgent follow-up not separable) • 19.2% given self-care advice, including home care or to seek further non-urgent medical attention independently (self-care only not separable)			21.9% (advice to self-present to the ED)	47.6%: • 28.5% returned to dispatch for emergency ambulance • 19.1% returned to dispatch for non-emergency ambulance	Low	Very low	30.5%
Lehm *et al.* (2017) [49]	Emergency medical communication centre (EMCC) (112 emergency number)	Non-urgent Level E patients (n=4,962 unique patients)	8.6% (advice only)	73.5% (other service/GP (urgency unknown)): • 10.3% referred to 'other' ('includes help from home care or the police, connection to a psychiatric facility, and the like') (urgency unknown) • 63.2% referred to GP (urgency unknown)		17.9%	N/A (Level E patients – only those triaged below ambulance examined)	Low	Very low	82.1%

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Lewis *et al.* (2021) [52]	NHS 111	NHS 111 calls in the Yorkshire and Humber regions (n=3,614,915 calls)	15.4% (not advised to seek additional care services; also includes incidences where the caller abandoned the call without receiving a recommendation)	66.4% (time frames unknown): • 61.2% advised to seek primary or community care (for example a GP, dental practitioner, or community pharmacy) within a given time frame • 5.2% advised to seek care from a service not covered by the above categories (services included depended on their local service configurations but may include, for example, mental health services, a district nurse, or a midwife)		6.7% (attend the ED by own means within a given time frame)	11.6% (transferred to 999 for an ambulance response)	High	Very low	81.8%
Spangler *et al.* (2020) [50]	Emergency medical dispatch centres	Calls triaged to non-emergency care (n=1,089 calls)	47.7% (closed pending re-contact)	52.3% (time frames unknown): • Mobile geriatric team (0.73%) • Other referral (14.2%) • Referral to advice line (30.7%) • Referral to ambulette (3.86%) • Referral to other transport (1.7%) • Referral to poison control (1.19%)		N/A (only calls referred to non-emergency care were examined)		High	Very low	100%

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Engelen (2023) [45] (total N=1,955 calls)	Nine out-of-hours service in primary care (OHS-PC) in the vicinity of the city of Utrecht in the Netherlands	Calls with transient ischaemic attack or stroke symptoms (n=1,955 calls)	28.1% (self-care/non-urgent appointment): • 2.2% (U4: appointment at OHS-PC or telephone advice (within 24 hours) (not separable)) • 25.9% (U5: no time condition – telephone advice)		42.2% (care within 1 or 3 hours): • 32.7% (U2: appointment at OHS-PC or GP home visit within 1 hour) • 9.5% (U3: appointment at OHS-PC or GP home visit within 3 hours)	N/A (level below ambulance is U2)	29.7% (U1: ambulance)	High	Very low	70.3% (but as per table, 42.2% had an appointment at OHS-PC or a GP home visit within 1 (32.7%) or 3 (9.5%) hours)

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Engelen (2023) [45] (overruled calls: n=368)	Nine OHS-PC services in the vicinity of the city of Utrecht in the Netherlands, but specific to calls where the Netherlands Triage Standard system was overruled by the nurse	Calls with transient ischaemic attack or stroke symptoms (n=368 overruled calls)	62.5% (self-care/non-urgent appointment): • 2.2% (U4: appointment at OHS-PC or telephone advice (within 24 hours) (not separable)) • 60.3% (U5: no time condition – telephone advice)		13.6% (care within 1 or 3 hours): • 7.9% (U2: appointment at OHS-PC or GP home visit (within 1 hour)) • 5.7% (U3: appointment at OHS-PC or GP home visit (within 3 hours))	N/A (level below ambulance is U2)	23.9% (U1: ambulance)	High	Very low	76.1% (but as per table, 13.6% had an appointment at OHS-PC or a GP home visit within 1 (7.9%) or 3 (5.7%) hours)

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Engelen (2023) [45] (calls not overruled: n=1,585)	Nine OHS-PC services in the vicinity of the city of Utrecht in the Netherlands, but specific to calls where the Netherlands Triage Standard system was not overruled by the nurse	Calls with transient ischaemic attack or stroke symptoms (n=1,585 calls not overruled)	20.1% (self-care/non-urgent appointment): • 2.1% (U4: appointment at OHS-PC or telephone advice (within 24 hours)(not separable)) • 17.9% (U5: no time condition – telephone advice)		48.8% (care within 1 or 3 hours): • 38.5% (U2: appointment at OHS-PC or GP home visit (within 1 hour)) • 10.3% (U3: appointment at OHS or GP home visit (within 3 hours))	N/A (level below ambulance is U2)	31.1% (U1: ambulance)	High	Very low	68.9% (but as per table, 48.8% had an appointment at OHS-PC or a GP home visit within 1 (38.5%) or 3 (10.3%) hours)
Leclair (2023) [46] (total n=2,195 calls)	Nine OHS-PC services in the vicinity of the city of Utrecht in the Netherlands	Calls with acute coronary artery syndrome symptoms (n=2,195 calls)	ED avoidance cannot by calculated, as triage levels were not separable. Reported only as: • High urgency: 63% (U1 (ambulance) and U2 (appointment at OHS-PC or GP home visit (within 1 hour))) • Low urgency: 37% (U3 (appointment at OHS-PC or GP home visit (within 3 hours)), U4 (appointment at OHS-PC or telephone advice (within 24 hours)), and U5 (no time condition – telephone advice))					High	Very low	N/A

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Leclair (2023) [46] (calls with GP consult: n=1,148)	Nine OHS-PC services in the vicinity of the city of Utrecht in the Netherlands, but specific to calls where supervising GP was consulted	Calls with acute coronary artery syndrome symptoms (n=1,148 calls with GP consult)	High urgency: 65.6%					High	Very low	N/A

Author (year)	Triage service	Population	Triage dispositions					NHLBI quality assessment	GRADE certainty of evidence	ED avoidance rate (%)
			Self-care	Attend alternative service (scheduled/non-urgent appointment)	Urgent follow-up	Present to ED	Ambulance			
Leclair (2023) [46] (calls without GP consult: n=1,047)	Nine OHS-PC services in the vicinity of the city of Utrecht in the Netherlands, but specific to calls where supervising GP was not consulted	Calls with acute coronary artery syndrome symptoms (n=1,148 calls without GP consult)	High urgency: 60.2%					High	Very low	N/A

• Maximum potential ED avoidance rate. Urgent follow-up included: speak to a clinician from our service immediately; COVID-19 risk clinical assessment service within 1 hour; COVID-19 risk clinical assessment service within 2 hours; COVID-19 risk clinical assessment service within 4 hours; speak to a primary care service within 1 hour; speak to a primary care service within 2 hours; and advised to make own way for urgent clinical assessment including self-presentation to ED (proportion not reported).

** Proportion was not explicitly reported in the paper but was calculated based on other percentages provided and disposition categories listed.

3.7.2.2.2 ED attendance

Four primary studies reported very low-certainty evidence on ED attendance in general triage services within a specified time period [48–50,52]. Three studies examined calls deemed non-urgent or low acuity only [48–50] and the fourth study examined all calls [52] (Table 38). This section reports studies by duration of follow-up at ED. One other study reported on ED attendance rates within an unspecified time frame following their pre-hospital remote triage call [43] and was therefore excluded from this analysis.

Table 38 Summary of evidence on ED attendance following use of general triage services

Author (year)	Triage service	Organisational level, staff, and technology used	Percentage of calls/ patients assigned non-urgent dispositions who attended ED	Percentage of calls/ patients assigned urgent dispositions who attended ED	Total ED attendances (as a percentage of all callers)	Duration
ED attendance Eastwood *et al.* (2017) [48]	Referral service	Regional service and data Nurses or paramedics Condition-specific computer-based questioning algorithm (Care Enhanced Call Centre)	14.9% (alternate service providers/self-care)	52.8% (ambulance/self-present to ED)	41.3%	48 hours (2 days)
ED attendance Lehm *et al.* (2017) [49]	EMCC	Regional service and data Nurse, doctor, or paramedics (healthcare professionals) Dispatch software guided by the Danish Index for Emergency Care	1 day: 24.3% 7 days: 26.0% 30 days: 27.7% (ED/GP/other/advice only (not separable but all below the need for an ambulance))		1 day: 24.3% 7 days: 26.0% 30 days: 27.7%	1, 7, and 30 days
ED attendance Spangler *et al.* (2020) [50]	Emergency medical dispatch centres	Regional data Nurses Computerised clinical decision support system used (not used for 30% of cases)	1 day: 16.2% 3 days: 19.2% 7 days: 23.9%	N/A (none referred to ED)	1 day: 16.2% 3 days: 19.2% 7 days: 23.9%	1, 3, and 7 days
ED attenance Lewis *et al.* (2021) [52]	NHS 111	Regional data Call handlers without clinical backgrounds, with clinical advisors available to support call handlers for challenging cases NHS 111 is known to use decision support software	10.8% (primary/community care/other services/self-care)	69.3% (transferred for ambulance response/attend ED)	21.6%	48 hours

3.7.2.2.2.1 Within 1 day of using general triage services

Two studies provided very low-certainty evidence on ED attendance rates within 1 day of a pre-hospital remote triage call [49,50] (Table 39).

The first study reported that within 1 day of the call, 24.3% of 4,962 Level E patients visited the ED [49]. There was a large proportion (47.2%) of Level E patients missing, as they were excluded due to invalid unique civil registration numbers preventing data linkage. There was also significantly more men (53.4%) than women (46.6%) in the sample (p<0.005) [49]. There was no adjustment for confounders, and the evidence was of very low certainty.

The second study examined 1,089 calls that were triaged to non-emergency care by emergency medical dispatch centres and reported that 16.2% of calls presented to the ED within 1 day of contacting the emergency medical dispatch centre [50]. Although this rate was not adjusted for confounders, multivariate logistic regression sensitivity analysis (adjusting for sex, age, weekday call, daytime call, prior contact, county, use of decision support, and onward referral) was conducted. Based on the graphs included, frequent prior contact with triage service (six or more contacts in previous six months) was associated with decreased odds of an ED visit while onward referral was associated with increased odds of an ED visit (no statistics were extractable; a graph illustrated the line of significance only). Other variables were not statistically significant. Overall, while callers were followed up for 30 days, 68% of ED presentations occurred in the first 24 hours. Spangler *et al.* reported significant data linkage issues, with data missing for 35.8% of calls; this was either due to missing personal identification numbers (33.7%; n=571 out of 1,696 calls) or to data entry issues (2.1%; n=36 out of 1,696 calls). The outcome of ED visit was collected by two nurses from medical records and had an agreement level of 98.5% (alpha=0.94) [50]. The certainty of the evidence was very low.

Table 39 Summary of evidence on ED attendance within 1 day of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	ED attendance rate (%)
ED attendance within 1 day Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962)	Surveillance system	Low	Very low	Among all patients triaged to below the need for an ambulance: 24.3%
ED attendance within 1 day Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Calls triaged to non-emergency care (n=1,089 calls)	Surveillance system	High	Very low	Among all calls triaged to below the need for an ambulance or ED attendance: 16.2%

3.7.2.2.2.2 Within 2 days of using general triage services

Two studies provided very low-certainty evidence on ED attendance rates within 2 days of a pre-hospital remote triage call [48,52]. A summary of the evidence is provided in Table 40.

Table 40 Summary of evidence on ED attendance within 2 days of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	ED attendance rate (%)
ED attendance within 48 hours Eastwood *et al.* (2017) [48]	Emergency care pathway: • Return for emergency ambulance dispatch • Non-emergency ambulance dispatch • Self-present at the ED Alternative care pathway: • Alternative service providers dispatched • Self-care (home self-care or a referral to visit their own healthcare professional)	Callers in metropolitan Melbourne deemed low acuity by the Australian emergency telephone number (n=103,768 calls)	Surveillance system	Low	Very low	41.3% of all callers: • Emergency ambulance: 62.8% • Non-emergency ambulance: 52.2% • Self-present at ED: 40.4% • Alternative service providers: dispatched 19.3% • Self-care 12.5%
ED attendance within 48 hours Lewis *et al.* (2021) [52]	High acuity: • Transferred for ambulance dispatch • Attend ED Low acuity: • Seek primary or community care • Seek other service (e.g. mental health services, a district nurse, or a midwife) • Self-care	NHS 111 calls in the Yorkshire and Humber regions (n=3,614,915 calls)	Surveillance system	High	Very low	21.6% of all callers: • Transferred for ambulance dispatch: 69.7% • Attend ED: 68.6% • Seek primary or community care: 8.5% • Seek other service: 16.1% • Self-care: 18.2%

The first study (n=103,768 calls initially deemed low acuity and passed on to the referral triage service) reported that 41.3% of callers ended up presenting to ED within 2 days of their call [48].

The authors report that 14.9% of those triaged to below ED level (12.5% of those directed to self-care and 19.3% of those dispatched alternative services) presented to the ED within 48 hours of their call. This compared with 52.8% ED attendance among calls triaged to the emergency care pathway (62.8% of cases referred to an emergency ambulance, 52.2% of cases referred to a non-emergency ambulance, and 40.4% of cases told to self-present to the ED).

These rates were not adjusted for confounders, but the authors did examine gender and age distribution for cases that presented to the ED across triage dispositions. They reported that the gender distribution for cases presenting to the ED was similar for all triage dispositions (52.6–55.5% were female). Those receiving triage disposition recommendations involving self-sourcing of care (self-present to ED and self-care advice) were younger (average age: 41 and 47 years) than those sent further care (average ages: 59, 60 and 70 years). The breakdown of the most common presenting problems by triage disposition is also reported for those presenting to the ED in Table 41 [48].

Eastwood *et al*. reported data linkage issues both specific to attendance at ED and overall. Specific to attendance at ED, no records were available for ED attendance at private hospitals unless patients were admitted. Overall, 84% of all cases triaged by the service had service case records available (n=103,768 out of 123,458 calls), and further loss to follow-up in relation to ED presentations is unknown. The certainty of the evidence is very low.

Table 41 Hospital management of cases that presented at ED following remote triage, by triage disposition

	Planned emergency presentations (emergency care pathways)		Unplanned emergency presentations (alternative care pathways)		
	Return for emergency ambulance dispatch	Non-emergency ambulance dispatch	Self-present at the ED	Alternative service providers dispatched	Self-care
ED record (percentage of cases referred to that pathway)	18,578 (62.8%)	10,348 (52.2%)	9,184 (40.4%)	2,207 (19.3%)	2,496 (12.5%)
Female (%)	54.3	53.2	55.5	53.2	52.6
Median age (years)	60	70	41	59	47
Ranking of five most common medical problems for cases presenting to the ED by triage disposition	1. Abdominal pain 2. Back pain 3. Dizziness or vertigo 4. Nausea and vomiting 5. Fever	1. Back pain 2. Abdominal pain 3. Urinary symptoms 4. Weakness or paralysis 5. Lower leg injury	1. Abdominal pain 2. Back pain 3. Flank pain 4. Nausea and vomiting 5. Urinary symptoms	1. Back pain 2. Nausea and vomiting 3. Dizziness or vertigo 4. Urinary symptoms 5. Abdominal pain	1. Back pain 2. Abdominal pain 3. Nausea and vomiting 4. Dizziness or vertigo 5. Constipation and rectal symptoms
Cases appropriate for ED-level intervention (absolute risk percentage)	77.8%	71.3%	70.6%	68.8%	60.3%

Source: Eastwood *et al.* 2017 [48]

The second study reported that 21.6% of all calls to NHS 111 in the Yorkshire and Humber regions (n=781,561 out of 3,614,915 calls) attended ED within 2 days of their call [52]. The total number of ED visits where breakdown by triage disposition was reported was not the same, at 776,692 (21.4%) rather than 781,561, and this difference in the number of ED attendances was not explained by the study authors. We present results based on the lower figure, as this figure was the sum of each triage disposition given separately. ED attendance rates were 10.8% among those triaged to below ED level (18.2% of callers who were told to self-care, 8.5% of callers who were told to seek primary or community care, and 16.1% of callers who were told to attend another service) and 69.3% among those triaged to ED level (69.7% of callers who were transferred for ambulance dispatch and 68.6% of callers who were told to attend the ED) [52]. While these rates were not adjusted for confounders, subgroup differences were examined in relation to age and involvement of a clinical advisor. Similar rates of ED attendances were observed for each triage disposition regardless of the caller's age group, and there was also little difference in average time to attend among those who went to the ED, with the majority doing so within 4 hours and almost all within 24 hours. Overall, around 21% of patients in the youngest age group (aged 16–44 years) and around 28% of patients in the oldest age group (aged 75 years and over) attended ED. There was also little difference overall in the percentage attending ED or time until ED attendance based on whether a clinical advisor handled the call or not. It was reported, however, that callers seemed slightly more likely to follow self-care advice when it was given by a clinical advisor [52]. There was no adjustment for chronological trends over the 4 years of data in this analysis, but the authors did report

that there was a slight rise in the proportion of NHS 111 calls that were followed by an ED attendance over the years studied (increasing from 20.7% in 2013 to 22.8% in 2017). Overall, however, the authors reflected that both the percentage of patients from each triage disposition attending ED and the median time taken to attend changed little over time. The certainty of the evidence is very low.

3.7.2.2.2.2.1 Subgroup comparisons for ED attendance within 2 days

Eastwood *et al.* reported a higher overall ED attendance rate of 41.3% among low-acuity callers to emergency services compared with 21.6% reported by Lewis *et al.* for all callers to NHS 111. Attendance rates were 14.9% [48] and 10.8% [52] for those triaged to below ED level. The first study (by Eastwood *et al.*) examined patients who were initially deemed low acuity (non-urgent) by the Australian emergency telephone number and then received telephone triage from nurses or paramedics, while the second study (by Lewis *et al.*) included all callers to NHS 111 and triage was conducted by non-clinical call advisors in the first instance. Rates of missing data were also much higher in the Eastwood *et al.* study [48] compared with the Lewis *et al.* study [52].

3.7.2.2.2.3 Within 3 days of using general triage services

One study provided very low-certainty evidence on ED attendance rates within 3 days of a pre-hospital remote triage call [50]. A summary of the evidence is provided in Table 42.

This study examined 1,089 calls that were triaged to non-emergency care by emergency medical dispatch centres in Sweden, and the authors reported that 19.2% of calls presented to the ED within 3 days of their call [50]. Although this rate was not adjusted for confounders, multivariate logistic regression sensitivity analysis in graph form (adjusting for sex, age, weekday call, daytime call, prior contact, county, use of decision support, and onward referral) identified that onward referral was associated with increased odds of an ED visit (no statistics were extractable; a graph illustrated the line of significance only). Significant data linkage issues were reported, with data missing for 35.8% of calls; this was due to missing personal identification numbers (33.7%; n=571 out of 1,696 calls) or to data entry issues (2.1%; n=36 out of 1,696 calls) [50].

Table 42 Summary of evidence on ED attendance within 3 days of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	ED attendance rate (%)
ED attendance within 3 days Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Calls triaged to non-emergency care (n=1,089 calls)	Surveillance system	High	Very low	Among all calls triaged to below the need for an ambulance or ED attendance: 19.2%

3.7.2.2.2.4 Within 7 days of using general triage services

Two studies reported very low-certainty evidence on ED attendance rates within 7 days of a pre-hospital remote triage call [49,50]. A summary of the evidence is provided in Table 43.

Table 43 Summary of evidence on ED attendance within 7 days of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	ED attendance rate (%)
ED attendance within 7 days Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962)	Surveillance system	Low	Very low	Among all patients triaged to below the need for an ambulance: 26.0%
ED attendance within 7 days Spangler *et al.* (2020) [50]	Non-emergency care (below the need for an ambulance or to take alternate transport to the ED)	Triaged to non-emergency care (n=1,089 calls; 903 unique patients once repeat contacts were removed)	Surveillance system	High	Very low	Among all calls triaged to below the need for an ambulance or ED attendance: 23.7% Among unique patients triaged to below the need for an ambulance or ED attendance: 23.6%

The first study was based on 4,962 Non-urgent Level E patients in the Central Denmark Region and reported that within 7 days of the call, 26.0% of Level E patients visited the ED [49]. There was a large proportion (47.2%) of Level E patients missing due to a data linkage issue. There were also significantly more men (53.4%) than women (46.6%) in the sample (p<0.005). There was no adjustment for confounders and the evidence was of very low certainty.

The second study examined 1,089 calls triaged to non-emergency care in emergency medical dispatch centres in Sweden and reported that 23.7% of calls presented to the ED within 7 days of contacting the emergency medical dispatch centre [50]. Although this rate was not adjusted for confounders, multivariate logistic regression sensitivity analysis in graph form (adjusting for sex, age, weekday call, daytime call, prior contact, county, use of decision support, and onward referral) identified that callers aged 65 years and over and callers who received onward referrals were associated with increased odds of an ED visit (no statistics were extractable; a graph illustrated the line of significance only). ED visits were also reported by triage dispositions within non-emergency care, including confidence intervals (CIs) (Table 44). Significant data linkage issues were reported, with data missing for 35.8% of calls; this was due to missing personal identification numbers (33.7%; n=571 out of 1,696 calls) or to data entry issues (2.1%; n=36 out of 1,696 calls) [50].

Table 44 ED visits by triage dispositions among calls triaged to non-emergency care

Triage disposition	Number of included calls	Number of ED visits	Percentage resulting in ED visit (95% CI)
Closed pending re-contact	519	103	19.8% (16.6–23.2)
Mobile geriatric team	8	1	12.5% (0–37.5)
Other referral	155	40	25.8% (20–32.9)
Referral to advice line	334	97	29.0% (24.4–33.5)
Referral to ambulette	42	13	31.0% (16.7–47.6)
Referral to other transport	18	4	22.2% (5.6–44.4)
Referral to poison control	13	0	0.0%

Source: Spangler *et al.* 2020 [50]

The authors then removed repeat contacts to the service (more than 1 call from the same caller) and identified 903 unique patients. Of these, 23.6% had a subsequent ED visit within 7 days. Additionally, the authors completed multivariate regression analysis for unique patients (adjusted for other covariates modelled, i.e. sex, age, weekday call, daytime call, frequent caller, region, decision support used, and onward referral) and reported that unique patients aged over 65 years were more likely to visit the ED within 7 days (adjusted odds ratio (OR): 1.48; 95% CI: 1.08–2.04) and that being referred onwards to an alternative service was associated with higher odds of visiting the ED within 7 days (adjusted OR: 1.58; 95% CI: 1.15–2.19). The certainty of the evidence was very low.

3.7.2.2.2.5 Within 30 days of using general triage services

One study reported very low-certainty evidence on ED attendance rates within 30 days of a pre-hospital remote triage call [49]. A summary of the evidence is provided in Table 45.

This study was based on 4,962 Non-urgent Level E patients in the Central Denmark Region and reported that within 30 days of the call, 27.7% (n=1,374 callers) of Level E patients visited the ED. There was a large proportion (47.2%) of Level E patients missing due to data linkage issues. There were also significantly more men (53.4%) than women (46.6%) in the sample (p<0.005). There was no adjustment for confounders.

Table 45 Summary of evidence on ED attendance within 30 days of using general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	ED attendance rate (%)
ED attendance within 30 days Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962)	Surveillance system	Low	Very low	All patients triaged to below the need for an ambulance: 27.7%

3.7.2.2.3 Overtriage

We identified very low-certainty evidence from two primary studies that assessed overtriage outcomes in general triage services [47,52]. Overtriage of a call occurs when a call receives triage disposition advice that is of a higher urgency than what is required for the medical symptoms (for instance, a caller is told to attend the ED, but on presentation to the ED, the caller is assessed as low urgency and not requiring ED services).

3.7.2.2.3.1 At entry to general triage services

One study provided very low-certainty evidence on overtriage based on assessment of triage data only rather than on clinical follow-up [47]. A summary of the evidence is presented in Table 36Table 46.

This study examined overtriage in two Danish out-of-hours primary care services – one employing a GP-led triage model and the other employing a nurse-led triage model (with a computerised decision support system guiding triage) – by evaluating 806 randomly selected general calls and 405 high-risk calls. The high-risk calls were individuals aged 30 years and over seeking assistance for abdominal pain. In addition to the decision support system, the nurse-led triage service also had the option to redirect calls to an on-call physician as needed. In order to enable a clear comparison, for calls that triage nurses redirected to a physician, only the portion of the call conducted by the nurse was available for assessment, and calls could be assessed as optimal if the decision to redirect the call was what would be expected.

Overtriage was assessed using the validated Assessment of Quality in Telephone Triage tool [47]. A single Assessment of Quality in Telephone Triage item using a 7-point scale to differentiate between levels of undertriage (ratings of 1–3), optimal triage (a rating of 4), and overtriage (ratings of 5–7) was used by 24 experienced physicians who were active in telephone triage and had completed a 2-day training course. Condensing the 7 points in order to create dichotomous scales for clinically relevant undertriage (ratings of 1 and 2 compared with ratings of 3–7) and clinically relevant overtriage (ratings of 6 and 7 compared with ratings of 1–5) revealed satisfactory interrater agreement in the assessment of accuracy. Assessors were blinded to both the type of call and the triage model used [47,56].

Clinically relevant overtriage was found in 5.9% of the high-risk calls. When examining high-risk calls that were GP led, the overtriage rate was 2.4%; conversely, the overtriage rate for high-risk nurse-led calls was 9.5%. For randomly selected calls, which were used as a way to give an overview of the service, clinically relevant overtriage was found in 6.7% of calls (and there was no examination of the rates within the GP-led service compared with the nurse-led service). The overtriage rates reported were not adjusted for confounders; however, the researchers modelled patient and call characteristics in order to check for associations with overtriage. In both the randomly selected and high-risk calls, there were no significant associations found with age, sex, time of call, and whether the call was on a weekend or weekday. However, among the high-risk calls, the nurse-led triage service had a significantly higher rate of observed overtriage relative to the GP-led triage service (relative risk: 3.9; 95% CI: 1.5–10.3). These data suggest that, for high-risk calls, nurses were more likely to give higher-urgency triage dispositions leading to overtriage of cases when compared with GPs. The certainty of the evidence was very low.

Table 46 Summary of evidence on overtriage rates of calls to general triage services measured using a validated tool

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Overtriage rate (%)
Overtriage based on a validated tool Graversen *et al.* (2023) [47]	Not reported	A random sample of general calls (n=806), and a specific subgroup (individuals aged 30 years or over seeking assistance for abdominal pain) identified as high-risk calls (n=405)	Surveillance system	High	Very low	Random subgroup: 6.7% High-risk calls: 5.9% (GP-led triage: 2.4%; nurse-led triage: 9.5%)

3.7.2.2.3.2 Within 2 days of using general triage services

One study analysed overtriage in a general triage service within 2 days of the call [52]. This study reported very low-certainty evidence. A summary of the evidence is presented in Table 47.

This study examined 3,614,915 calls of every triage disposition to NHS 111 in the Yorkshire and Humber regions in the UK over a 4-year period [52]. The authors linked all calls to an ED record, where possible. From this, Lewis *et al.* were able to determine how many calls with an ED record were admitted to hospital, were treated in an ED and discharged, or were determined to be non-urgent ED attendees. Therefore, from the data provided, we can determine the rate of overtriage among high-urgency triage dispositions (those advised to attend the ED or who were transferred for ambulance dispatch), as we know how many of each triage disposition were classified as non-urgent upon presenting to the ED. The authors report that from the triage disposition to attend the ED, 11.3% of callers were determined to be non-urgent upon presentation to the ED, suggesting that 11.3% of callers who were told to attend the ED were not in need of emergency care and were therefore overtriaged. Similarly, when examining the triage disposition of transfer for ambulance dispatch, 3.6% of callers assigned to this disposition were determined to be non-urgent upon presentation to the ED, suggesting that 3.6% of callers assigned to this disposition were not in need of emergency care and were therefore overtriaged. Thus, based on all ED presentations within 48 hours of their initial call, at least 1.2% of all calls were overtriaged. There was no adjustment for confounders, and the certainty of the evidence is very low.

Table 47 Summary of evidence on overtriage rates of calls to general triage services based on face-to-face assessment within 2 days

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Overtriage rate (%)
Overtriage based on face-to-face assessment within 48 hours Lewis *et al.* (2021) [52]	High acuity: • Transferred for ambulance dispatch • Attend ED Low acuity: • Seek primary or community care • Seek other service (e.g. mental health services, a district nurse, or a midwife) • Self-care	NHS 111 calls in the Yorkshire and Humber regions (n=3,614,915 calls)	Surveillance system	High	Very low	1.2% of all calls 6.6% of calls triaged to ambulance or ED (3.6% of those triaged to transfer for ambulance dispatch 11.3% of those advised to attend ED)

3.7.2.2.4 Case resolution

One study examined the outcome of case resolution at 1 day after referral. Case resolution is defined as evidence of no healthcare used within a given time period after being triaged to self-care, primary care, and/or alternative service triage dispositions.

We identified evidence from one study of general triage services that gave outcomes related to case resolution within 1 day of pre-hospital remote triage [42]. A summary of the findings is provided in Table 48.

Hodgins *et al.* analysed data from a general triage service, NHS 24 in Scotland, and identified 97,619 young adult callers aged 15–34 years reporting chest pain as the reason for their call [42]. The analysis tracked these callers from their initial NHS 24 triage disposition to their next unscheduled care service contact within 24 hours from the initial call. The study reported that 10.6% of callers who were advised to self-care attended another service within 24 hours. Therefore, 89.4% of callers given a self-care disposition can be considered to have their case resolved or 7.4% of callers overall. There were missing data for 5.1% of triage dispositions in this study cohort. There was no adjustment for confounders and the certainty of the evidence was very low.

Table 48 Summary of evidence on case resolution rates in general triage services within 1 day

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Case resolution rate (%)
Healthcare utilisation in follow-up period beyond ED attendance and admissions Hodgins *et al.* (2022) [42]	• Call an ambulance • Self-transport to ED • GP house visit within 1-hour • GP house visit within 2-hours • Primary care out-of-hours (PCOOH) appointment within 1-hour • PCOOH appointment within 2-hours • PCOOH appointment within 4-hours • GP house visit within 4-hours • Scheduled appointment • Self-care	All calls by young adults aged 15–34 years with chest pain as the reason for their call (n=97,619 callers)	Surveillance system	High	Very low	7.4% of all callers

3.7.2.2.5 Healthcare utilisation in follow-up period beyond ED attendance and admissions

We identified very low-certainty evidence from two studies of callers who used general triage services and that provided outcomes related to healthcare utilisation in the follow-up period for their specific study populations [42,49]. Hodgins *et al.* provided evidence for the follow-up time point of 24 hours, while Lehm *et al.* provided evidence for the follow-up time points of 1, 7, and 30 days. A summary of the evidence can be found in Table 49.

Table 49 Summary of evidence on healthcare utilisation at different time points following the use of general triage services

Outcome	Triage levels	Population	Study design	NHLBI quality assessment	GRADE certainty of evidence	Follow-up healthcare utilisation
Healthcare utilisation in follow-up period beyond ED attendance and admissions Hodgins *et al.* (2022) [42]	• Call an ambulance • Self-transport to ED • GP house visit within 1-hour • GP house visit within 2-hours • Primary care out-of-hours (PCOOH) appointment within 1-hour • PCOOH appointment within 2-hours • PCOOH appointment within 4-hours • GP house visit within 4-hours • Scheduled appointment • Self-care	All calls by young adults aged 15–34 years with chest pain (n=97,619 callers)	Surveillance system	High	Very low	Next unscheduled care service contact was most likely to be the service to which callers were initially triaged to
Healthcare utilisation in follow-up period beyond ED attendance and admissions Lehm *et al.* (2017) [49]	Level E (below the need for an ambulance)	Non-urgent Level E patients (n=4,962)	Surveillance system	Low	Very low	58% had no further contact with the healthcare system regarding acute conditions (within 1 day of call) or with their GP (within 7 days of call) 5.9% called again within 1-day

The first study analysed data from a general triage service, NHS 24 in Scotland, and identified 97,619 young adult callers aged 15–34 years for whom chest pain was recorded as the reason for the call [42]. The analysis tracked these callers from their initial NHS 24 triage disposition to their next unscheduled care service contact within 24 hours from the initial call. Results from the initial triage decision to the next unscheduled healthcare use within 24 hours are shown in Table 50. Overall, the data suggest that the initial triage category of advice given to callers is the most likely service area in which these callers would appear again. Although overall callers from each initial triage disposition also appeared in every service.

Table 50 NHS 24 initial triage dispositions compared with second unscheduled service contacted within 24 hours (or 1 day) in Hodgins et al. (2022)

Triage disposition	Second unscheduled service contacted after NHS 24 call				
	NHS 24	ED	Out-of-hours GP	Ambulance	No contact with a service within 24 hours
Call an emergency ambulance	3.3%	4.8%	1.6%	87.5%	2.8%
Self-transport to the ED	3.5%	80.1%	1.9%	3.1%	11.3%
GP house visit (within 1, 2, or 4 hours)	5.4–7.0%	0.5–2.3%	84.6–85.5%	5.5–6.9%	0.8–1.4%
PCOOH appointment (within 1, 2, or 4 hours)	3.8–4.7%	2.5–3.4%	87.4–89.8%	0.8–3.2%	1.4–3.1%
Make a scheduled appointment	13.5%	8.3%	4.2%	4.2%	69.1%
Self-care	4.1%	3.6%	2.3%	0.6%	89.4%

Source: Hodgins *et al*. 2022 [42]

There were missing data for 5.1% of triage dispositions in this study cohort. There was no adjustment for confounders and the certainty of the evidence was very low [42].

The second study was based on 4,962 Non-urgent Level E patients who were tracked in order to determine their healthcare utilisation within 1, 7, and 30 days of their initial call (Table 51) [49]. The authors found that 57.9% of Level E patients had no further contact with their GP (within same week of their call) or with the healthcare system (within 1 day of the call) for acute conditions. Notably, 72.0% of patients were known to have been advised to attend the ED or their GP, and it is unknown which patients did and did not have further contact, although it is clear that some patients who were advised to go to the ED or their GP did not do so based on these data. Overall, 10.4% of all the initial Level E patients contacted their GPs within 1 week and 24.3% of patients visited the ED within 1 day of their call.

It was also reported that 5.9% of all Level E patients called the service again within 1 day (Table 51). Of the repeat callers within 1 day, 16.0% were assigned level A, 44.7% were assigned level B, 0.0% were assigned levels C or D, and 39.3% were given Level E again.

Table 51 Level E patients' healthcare utilisation within up to 30 days of using general triage services

Outcome	Percentage of Level E patients
No further contact (within 1 day)	57.9%
Called again:	
Within 1 day	5.9%
Within 7 days	8.5%
Within 30 days	11.5%
GP:	
Within 1 week	10.4%
Within 4 weeks	11.7%
ED:	
Within 1 day	24.3%
Within 7 days	26.0%
Within 30 days	27.7%

Source: Lehm *et al*. 2017 [49]

In addition to missing triage disposition data, there was also a large proportion (47.2%) of Level E patients missing due to a data linkage issue. There was no adjustment for confounders and the evidence was of very low certainty.

4 Discussion

4.1 Summary of findings

A total of 14 primary studies were included in this systematic review.

Of these 14 primary studies, 3 primary studies (1 cluster randomised controlled trial (RCT) and 2 surveillance system studies) addressed specific triage services, i.e. triage services which specialise in triaging for particular conditions or symptoms only [39–41]. These triage services can be targeted towards the general population or, as was the case in the three studies examining specific triage services that we included in this review, towards specific subgroups. The primary aim of specific triage services is to accurately identify or rule out the specified condition, or to assess and triage a condition-related exacerbation or episode in relevant subgroups. All three primary studies on specific triage services that we included in this review involved specific triage services for defined subgroups with a pre-existing condition, i.e. pregnancy [39], myasthenia gravis [41], and hereditary angioedema . No studies on specific triage services targeting the general population, such as a specific triage service for suspected stroke, were found.

The remaining 11 studies (all primary studies employing a surveillance system approach) addressed general triage services, i.e. triage services used by the general population or specific subgroups which are not tailored to triaging for one or more named conditions. While the services in these studies were not tailored to particular conditions, they also naturally collect data on specific symptoms, and 5 of the 11 studies on general triage services included in this review had opted to examine only calls related to particular symptoms. The selected symptoms were chest pain or discomfort [42,44,46]; symptoms of COVID-19 [43]; and symptoms of transient ischaemic attack or stroke [45]. In relation to chest pain, two studies were restricted to calls from particular age groups (young adults aged 15–34 years [42] and adults aged 36 years or over [44]), while the third study included all callers aged 18 and over of but was focused on success in the detection of acute coronary artery syndrome [46]. One of the 11 studies on general triage services opted to examine both a random sample of all callers as well as a specified high-risk subgroup based on age (30 years and over) and the symptom of abdominal pain [47]. The remaining five included studies on general triage services [48–52] were not limited based on symptoms or condition, but mostly opted to focus on calls triaged to particular dispositions. Four of these studies were limited to calls deemed less serious and that were triaged below ambulance-level triage disposition [48–51]. Only one study included all callers and all triage dispositions [52].

The summary of findings is reported in relation to safety and effectiveness outcomes, with findings for specific and general triage services presented separately for each outcome. In order to be included in this review, all studies had to include a safety outcome. Thirteen of the 14 included studies also provided at least one effectiveness outcome; the study by Inokuchi *et al.* assessed the safety but not the effectiveness of a general triage service [51]. Overall, there is still insufficient good-quality evidence to establish the safety and effectiveness of remote pre-hospital triage for appropriate ED attendances and service use, and there was wide variation across studies with respect to populations examined, conditions or symptoms triaged for, and triage disposition options included. The variation in populations, conditions or symptoms, and triage dispositions made grouping or comparing findings largely impossible.

4.1.1 Research question 1: Are remote pre-hospital triage services safe for adults seeking unscheduled care?

4.1.1.1 Specific triage services

The safety outcomes assessed in the three specific triage studies included mortality (one study), hospital admissions (two studies), accuracy of triage compared with initial hospital or ED assessment (two studies), accuracy of triage compared with later clinical follow-up (one study), and intubations (one study).

The cluster RCT reported very low-certainty evidence indicating no significant difference in mortality related to hereditary angioedema attacks in the specific triage intervention group compared with the usual care group .

Two studies examined rates of admission to hospital and intensive care units (ICUs). The cluster RCT found statistically significantly lower hospital admissions for hereditary angioedema attacks over 2 years in the specific triage intervention group compared with the usual care group [40]. The same study reported no significant difference in ICU admissions between study groups. The surveillance system study on pregnant women who were referred to hospital reported that no pregnant patients who were triaged to intermediate urgency were hospitalised with a life-threatening situation, compared with 0.8% of patients who were triaged to high urgency, thus indicating no undertriage of life-threatening situations in pregnant women . Taken together, these studies on follow-up admission to hospital as an indicator of accuracy provide some very low-certainty evidence to support the safety of specific triage services.

Two surveillance system studies reported very low-certainty evidence in relation to the accuracy of remote triage compared with initial hospital or ED assessments. The study on pregnant women reported 53% agreement between specific triage urgency levels (intermediate and high urgency) and the urgency levels assigned at face-to-face hospital assessments, with a 16% undertriage rate [39]. The study on myasthenia gravis patients reported a sensitivity of 80% (true positive cases), a specificity of 60% (true negative cases), and a positive predictive value of 71% for detecting myasthenia gravis exacerbations. However, 11% of calls were undertriaged overall (i.e. patients who were advised to stay home presented to the ED with diagnosed exacerbations) [41].

The study on pregnant women referred to the hospital also reported very low-certainty evidence on accuracy compared with later clinical follow-up [39]. After clinical assessment, urgent care was needed in 8% of all calls, and the majority (77.5%) of calls referred to the hospital required a consultation only, with 77% of intermediate-urgency calls and 78% of high-urgency calls sent home after a consultation.

The cluster RCT on hereditary angioedema also reported very low-certainty evidence on intubation rates, and indicated no significant difference in intubation rates between the specific triage intervention and usual care groups over the 2-year study period [40].

4.1.1.2 General triage services

The safety outcomes assessed in the 11 studies on general triage services included mortality (3 studies), hospital admissions (5 studies), and other indicators of undertriage (9 studies). Other indicators of undertriage included the accuracy of general triage services compared with face-to-face assessments (five studies); the accuracy of general triage services compared with final diagnosis (two studies); the accuracy of general triage services based on serious adverse events (one study); and the accuracy of general triage services based on a validated tool (one study).

Three studies reported very low-certainty evidence on mortality at either different time points or in different populations [42,44,49]. The first study reported a 7-day mortality rate of 0.02% among young

adult callers with chest pain who were triaged to below the need for an ambulance or presentation to the ED [42]. The second study reported a same-day mortality rate of 0.12%, a 7-day mortality rate of 0.8%, and a 30-day mortality rate of 1.5% among unique patients triaged to Level E (i.e. below the need for an ambulance) [49]. The third study reported a 30-day mortality rate of 0.2% for callers aged 36 years and over with chest pain who were triaged to below the need for ED attendance [44].

Five studies assessed hospital admissions, reporting very low certainty evidence across all studies [42,48–50,52]. The first study reported admission rates of 8.6%, 10.5%, and 12.0% within 1, 7, and 30 days, respectively, of general triage among patients triaged to Level E (i.e. below the need for an ambulance) [49]. The second study reported admission rates of 5.4%, 7.1%, and 9.1% within 1, 3, and 7 days, respectively, among calls triaged to below the need for an ambulance or taking alternate transport to the ED [50]. The third study reported a significantly higher likelihood of calls triaged to ambulance or ED attendance levels being admitted to hospital compared with calls triaged to alternative service providers or self-care. Specifically, hospital admission rates within 2 days of using the general triage service were 6.5% among those triaged to below the need for an ambulance or presentation to the ED (11.1% for those dispatched alternative service providers and 5.1% for those provided self-care advice) [48]. The fourth study reported that 4.2% of callers to the NHS 111 line in the Yorkshire and Humber regions in the UK who were triaged to below the need for an ambulance or presentation to the ED were admitted to the hospital within 3 days of their call [52]. Finally, the fifth study reported that 6.8% of young adult callers with chest pain who were triaged to below the need for an ambulance or presentation to the ED were admitted to hospital within 7 days of their call [42].

The two studies reporting on hospital admissions within 3 days were similar in that both assessed regional data from a national service dataset using a decision support system; however, they were different with respect to the staffing of the triage service and the populations included in the study [50,52]. The respective 3-day admission rates for those triaged to below the need for an ambulance or presentation to the ED of 7.1% [50] and 4.2% [52] could possibly suggest that consistent use of a decision support system may be associated with lower admission rates at 3 days, although it is not possible to draw a strong conclusion given the lack of adjustment for confounders and the very low certainty of the evidence.

Five studies reported on the accuracy of general triage services compared with face-to-face assessments conducted by healthcare professionals following remote triage [42,48,50–52]. The first study reported an undertriage rate of 1.6% (within 6 hours of the call) among calls triaged to below the need for an ambulance but advised to visit a hospital within 1 or 6 hours when compared with a face-to-face assessment completed by a doctor, meaning that 1.6% of callers were deemed to have needed an ambulance upon a home visit by a doctor [51]. The second study, based on those who presented to the ED without a referral and who were judged to need care above the assigned triage disposition level, reported an undertriage rate of 8.7% within 1 day of the general triage call, 10.6% within 3 days of the call, and 13.1% within 7 days of the call [50]. The third study reported an undertriage rate of 9.6% within 2 days of calling a general triage service based on callers who were assigned to low triage dispositions presenting to ED and not being classed as non-urgent [52]. The fourth study reported an undertriage rate of 9.5% within 2 days of the general triage call compared with subsequent face-to-face assessment of severity in the ED [48]. The fifth study, which was specific to calls from young adults with chest pain, reported an undertriage rate of 2.4% within 7 days for calls triaged to below the need for an ambulance or presentation to the ED based on assessment in hospital determining a requirement for urgent treatment [42].

The two studies reporting on the accuracy of remote triage based on face-to-face assessment within 2 days were similar, as both assessed regional data, involved decision support tools/systems, and were not limited to calls with particular symptoms, allowing us to draw cautious comparisons [48,52]. The key

difference observed between these studies was the type of staff completing triage. The very similar accuracy rates for calls triaged to below the need for an ambulance or presentation to the ED of 9.6% [52] and 9.5% [48] suggests that triage by non-clinical staff with clinical support may offer similar accuracy to triage by clinical healthcare professionals, although it is not possible to draw a strong conclusion on this outcome given the lack of adjustment for confounders and the very low certainty of the evidence.

Under the 'other indicators of undertriage' heading, two studies reported on the accuracy of the initial possible diagnosis compared with the final diagnosis. For one study the overall sensitivity for appropriately triaging actual cases of transient ischaemic attack or stroke based on symptoms was 73.5%, with 26.5% of true cases being missed [45]. The overall sensitivity for appropriately triaging actual cases of acute coronary artery syndrome in the second study was 78.5%, with 21.5% of true cases being missed [46]. Taken together, these studies, which examined the same triage service in the Netherlands, therefore provide very low-certainty evidence to suggest that a high proportion of both acute coronary artery syndrome and transient ischaemic attack or stroke cases were not identified through remote triage. However, as no meta-analysis was possible, strong conclusions based on this comparison cannot be drawn.

One study, which was specific to callers to a general triage service with symptoms of COVID-19, reported on the accuracy of initial triage disposition based on the subsequent occurrence of serious adverse events at 3-, 7-, and 30-day follow-up time points [43]. Overall sensitivity at 30 days was 74.2%, with higher values at 7 days (74.4%) and 3 days (81.4%). Sensitivity increased to 77.3% when using triage assessments from final calls compared with first calls, and in phase 2 of the study (when loss of taste and smell were added as symptoms), sensitivity rose to 85.7%, although false positives also increased from 38.5% to 48.5%, meaning that higher numbers of patients were triaged to urgent care unnecessarily.

Finally, the study reporting on the accuracy of a general triage service based on a validated tool examined this in two subgroups: high-risk calls (callers aged 30 years and over with abdominal pain), and a random sample of general calls [47]. Using an item from the Assessment of Quality in Telephone Triage tool, a clinically relevant undertriage rate of 5.5% was reported in the random subgroup of general calls. In high-risk calls, a clinically relevant undertriage rate of 7.9% was reported.

4.1.2 Research question 2: In the case of remote pre-hospital triage services which appear to be safe, are these services effective in reducing ED attendances?

4.1.2.1 Specific triage services

All three specific triage services studies assessed the effectiveness of remote triage. The effectiveness outcomes measured were triage disposition (three studies), ED attendance (one study), and overtriage (two studies).

All three studies (two surveillance system studies and one cluster RCT) reported very low-certainty evidence regarding triage disposition outcomes in specific triage services. The first study excluded calls triaged to self-care and reported triage dispositions for pregnant callers as follows: high urgency (64% of calls) and intermediate urgency (36% of calls) . The second study reported triage dispositions for callers with myasthenia gravis as follows: attend the ED (62% of calls) and stay at home and monitor symptoms (38% of calls) . The third study, a cluster RCT, reported no significant difference in patients with hereditary angioedema directed to monitor at home between the intervention and usual care groups [40].

The surveillance system study on callers with myasthenia gravis also reported very low-certainty evidence on ED attendance, with 73.3% of calls resulting in an ED presentation .

Both surveillance system studies on specific triage services reported very low-certainty evidence on overtriage rates in their differing study populations: people with chronic myasthenia gravis [41] and pregnant women [39]. In spite of this and other study differences, including differing types of staff completing triage and differing use of technology, a similar rate of overtriage among those triaged to go to hospital was observed across these two studies, at 28.6% [41] compared with 30.3% .

4.1.2.2 General triage services

Ten of the 11 studies on general triage services assessed the effectiveness of remote triage. The effectiveness outcomes assessed were triage disposition (nine studies), ED attendance (four studies), overtriage (two studies), case resolution (one study), and healthcare utilisation (two studies).

Nine studies reported on triage disposition, reporting very low certainty evidence across all studies. It was possible to calculate ED avoidance rates (i.e. the proportion triaged by the service to below the need for an ambulance or presentation to the ED) for eight of these studies, with 30.5–100% of calls/patients directed to services below ED level [42–45,48–50,52]. This range for ED avoidance rates included one study that was specific to services which dispatch urgent alternative service providers to patients' homes [48], and another study that was specific to non-serious calls [50]. When these two studies were excluded, the remaining six studies reported triaging between 61.8% and 90% of calls to below the need for an ambulance or presentation to the ED. Lewis *et al.*, the only study to examine all calls to a general triage service, reported an ED avoidance rate of 81.8%, with 15.4% of callers receiving no recommendation to seek any additional care [52].

Two of the nine studies examined grouped triage dispositions for the same nine out-of-hours primary care services in the Netherlands [45,46]. The first study examined callers reporting symptoms of transient ischaemic attack or stroke [45] and the second examined callers reporting symptoms of acute coronary artery syndrome [46], allowing us to draw a cautious comparison. For transient ischaemic attack or stroke symptoms, 62.8% of calls were triaged to a high urgency (ambulance, or GP home visit or OHS-PC appointment within 1 hour) compared with 63.0% of calls for symptoms of acute coronary artery syndrome. Notably, both studies reported similar proportions of patients triaged to a high-urgency triage disposition based on symptoms suggestive of differing but potentially serious conditions.

Four studies reported on ED attendance, reporting very low certainty evidence across all studies. The first study, which only assessed non-urgent Level E patients (triaged to below the need for an ambulance) by design, reported ED attendance rates of 24.3% within 1 day of the triage call, 26.0% within 7 days of the triage call, and 27.7% within 30 days of the triage call [49]. The second study, which similarly only analysed calls triaged to non-emergency care (below the need for an ambulance or presentation to the ED) by design, reported ED attendance rates of 16.2% within 1 day of the triage call, 19.2% within 3 days of the triage call, and 23.7% within 7 days of the triage call [50]. The third study, assessing callers initially deemed low acuity and passed onto the referral triage service, reported that 41.3% of callers ended up presenting to ED within 2 days of their call [48]. The fourth study reported on ED attendance among general callers to the NHS 111 general triage line [52]. Within 2 days of the general triage call, 21.6% of all callers attended the ED.

The two studies reporting on ED attendance within 2 days were similar, as both assessed regional data, involved decision support tools/systems, and were not limited to calls with particular symptoms, allowing us to draw cautious comparisons. The key difference observed between these studies was the type of staff completing triage, with triage delivered by trained non-clinical call handlers with input from clinical staff as needed in the study by Lewis *et al.* [52], and by nurses or paramedics in the study by Eastwood *et al.* [48]. While accuracy of the remote triage services compared with face-to-face assessment within 2 days was very similar in these studies, indicating similar safety for those triaged to below the need for an

ambulance or presentation to the ED, the outcome of ED attendance did illustrate apparent differences in terms of effectiveness given the higher rate of 41.3% reported by Eastwood *et al.* compared with the rate of 21.6% reported by Lewis *et al*. However, in addition to differences in the type of staff conducting triage, there was also a difference between these studies in relation to the route to the triage service. While the Lewis *et al.* study was based on all calls made to NHS 111, the Eastwood *et al.* study examined a subset of calls transferred by dispatch to a lower-level triage service after they were deemed to not need an ambulance or ED referral. As a result, the two studies were also different in the proportions of callers ultimately directed to ED (69.5% in Eastwood *et al*. compared with 18.3% in Lewis *et al.*) by the triage service. The actual ED attendance rates observed indicated some non-compliance and undirected ED attendance in Lewis *et al.* (69.3% of those who were directed to attend the ED did so, while 10.8% of those directed to other triage dispositions attended the ED), and undirected ED attendance as well as an even greater apparent lack of compliance in Eastwood *et al.* (just 52.8% of those referred to the ED attended or had a linked ED record, and 14.9% of those directed to triage dispositions below ED level attended the ED). Rates of missing data were also much higher in the Eastwood *et al.* study [48] compared with the Lewis *et al.* study [52]. Importantly, it is therefore not possible to draw any strong conclusions on this outcome given the rate of missing data in the Eastwood *et al.* study and the lack of adjustment for confounders and very low certainty of the evidence in both studies.

Two studies reported very low-certainty evidence on overtriage rates. The first study assessed overtriage rates at entry to a general triage service in both a random sample of general callers and a high-risk subgroup of callers (individuals aged 30 years and over with abdominal pain) [47]. Two triage models were compared in the high-risk group, and an overtriage rate of 2.4% was reported in the GP-led triage model, whereas an overtriage rate of 9.5% was reported in the nurse-led triage model. For the random sample of general calls, an overtriage rate of 6.7% was reported when both models were combined. For the second study, we calculated an overtriage rate based on the number of calls triaged to high urgency which were later classed as non-urgent upon ED presentation as a proportion of all calls. Overall, 1.2% of all calls were overtriaged as 11.3% of those referred to the ED and 3.6% of those triaged to ambulance dispatch were deemed non-urgent upon presentation to the ED [52].

One study provided very low-certainty evidence on case resolution for young adults with chest pain within 1 day of calling the NHS 24 triage service [42]. A case resolution rate of 89.4% was reported among calls triaged to self-care, which indicated an overall case resolution rate of 7.4% for all calls.

Two studies assessed follow-up healthcare utilisation outcomes outside of ED attendance and admissions, and both studies reported very low-certainty evidence. The first study tracked calls by young adults reporting chest pain from their initial NHS 24 triage disposition to their next unscheduled care service contact within 24 hours [42]. The data suggested that the initial triage category of advice given to callers was the most likely service area in which these callers would appear again. The second study analysed data from low-acuity patients and tracked the healthcare utilisation of the study population within 1, 7, and 30 days of their initial call [49]. Of these callers, 57.9% had no further contact with the healthcare system regarding acute conditions (within 1 day of the call) or with their GP (within 7 days of the call).

4.1.3 Remote triage comparisons

Given between-study differences (specific subpopulations, outcome assessment, and follow-up periods), it was not possible to comment on patterns across studies in relation to subgroups of interest as listed in the study protocol (i.e. particular patient populations, clinical governance models, organisational level, and involvement of technology). Moreover, in relation to triage service modes, only studies based on telephone triage were identified. Several studies did, however, report on within-study differences relating to clinical governance models and the use of technology.

4.1.3.1 Clinical governance models

In relation to clinical governance models, there were within-study comparisons of triage by a nurse or a doctor, by a nurse with or without doctor consultation, and by non-clinical advisors alone compared with non-clinical advisors with the support of a clinical advisor. Importantly, none of these studies presented these comparisons in a way that accounted for confounders related to the triageur or the involvement of senior triageurs being dependent on region [47], wait time [44], or perceived need [46,52].

Two studies compared triage by doctors and by nurses: Graversen *et al.* did so in relation to patients aged 30 years and over with abdominal pain (deemed high risk) [47], and Sax *et al.* did so in relation to callers aged 36 years and over with chest pain [44]. These studies are not comparable due to differences between the studies in terms of specific subpopulations, outcome assessment (a tool in Graversen *et al.* compared with clinical follow-up in Sax *et al.*), and study design (in the Sax *et al.* study, assignment of calls was based on wait time, while in the Graversen *et al.* study, it was based on location (i.e. two services in different regions)). Findings also differed between the studies, with Graversen *et al.* indicating that nurse-led triage was safer but less efficient based on undertriage and overtriage rates, while Sax *et al.* reported a slightly lower mortality rate in doctor-led triage calls compared with nurse-led triage calls, implying that doctor-led triage may be safer, although no statistical significance testing was done. Sax *et al.* also reported that physicians directed more calls to lower triage levels (i.e. below ED level), again implying higher efficiency related to doctor-led triage. In both of these studies, nurse-led triage involved the use of a decision support tool while triage by a physician did not, but in the Sax *et al.* study, doctor-led triage did include access to real-time medical records that the nurses could not access. A third study investigated the involvement of doctors in triage compared with nurses alone, and it found that final diagnosis of acute coronary artery syndrome had significantly lower sensitivity (69% compared with 78.5% overall) in calls where nurses opted to consult with a supervising GP [46], suggesting (like Graversen *et al.*) that calls in which GPs were involved in triage were less safe. However, given that no confounders were adjusted for in the Leclair study in relation to the type of calls nurses requested GP input on, this may not be about the triageur but rather related to the more complex or challenging calls for which nurses may seek GP support.

Finally, in relation to the involvement of clinical advisors compared with non-clinical call takers alone, Lewis *et al.* did not provide usable safety outcome data, but did report that clinical advisors directed more callers to self-care and other services and that callers seemed a little more compliant with advice to self-care from a clinical advisor [52].

4.1.3.2 Use of technology (decision support)

Four studies did not report the use of a decision support system [40,41,51,52], but it is assumed that the data presented in the Lewis *et al.* study did involve the use of a clinical decision support system given that NHS 111 is known to employ such a system [54]. It is not possible to compare studies which do and do not report the use of decision support tools due to other differences in the studies (such as differing subpopulations, type of staff triaging, outcomes assessed, and follow-up periods).

In terms of within-study comparisons, Spangler *et al.* reported that decision support was used in 70% of calls and was not significantly associated with ED presentations within 7 days, with no examination of other outcomes on this basis [50]. In other studies, use of decision support technology or not was linked to clinical governance models, with nurse-led triage systems using an algorithm or computerised decision support system, while the doctors used clinical skills only in one study [47] and based their decisions on clinical skills and real-time access to medical records in another study [44]. Study conclusions were mixed regarding which approach was safer.

One study also reported on calls where nurses opted to overrule the triage tool compared with calls where they did not, reporting no significant difference in accuracy based on final diagnosis of transient ischaemic attack or stroke [45]. There was no adjustment for confounders in relation to the types of calls nurses tended to overrule, and also no data on the proportion of these calls that GPs were consulted on.

4.1.3.3 Particular patient populations

Given the diversity of included studies in relation to triage service components (staff, disposition levels, use of technology), outcomes assessed, and follow-up periods, it was not possible to reflect on patterns in terms of the safety and effectiveness of triage in particular patient populations.

While a number of studies focused on patients deemed less serious [48–51], the definitions and processes by which these patients were identified varied across studies, thus ruling out our ability to draw any meaningful comparisons between them.

In relation to particular symptoms, three studies focused on calls where chest pain was reported, but were otherwise diverse, with two of these studies focusing on chest pain in distinct age groups [42,44] and the third focusing on the accuracy of triage based on diagnoses of acute coronary artery syndrome only [46].

4.1.3.4 Organisational level: National compared with regional or local

Only one study included in this review reported on national data for a national triage service [42], while four other studies presented regional data on a national triage service [40,43,50,52].

Two studies were on local practice-based triage services: one was a single-centre pilot [41] and the other included four hospitals serving pregnant women [39]. The remaining studies assessed regional triage services [44–49,51]. Given between-study differences (specific subpopulations, outcome assessment, and follow-up periods), it was not possible for this review to comment on patterns in relation to the organisational level of triage services.

4.2 Comparison of findings

4.2.1 Comparison with other reviews

In contrast to other reviews on pre-hospital triage services, we included both specific and general triage services in our review rather than focusing solely on specific subpopulations [13–16,57] or excluding specific subpopulations and conditions to focus only on general populations [12]. All modalities were included in our search rather than telephone triage only [8,10,18,21,58]. Our review also differed from past reviews [7,10,12,14] in that safety outcomes were required for inclusion of a study.

Contrary to some similar reviews [7,10,23], we did apply some restrictions on included study designs, although we did not restrict the review solely to comparative studies in line with Rushton *et al.* [12], as alongside trials and before and after studies, surveillance system-type studies assessing all users or episodes of triage in a system were also considered useful in answering our research questions.

In order to ensure rigour, we published our review protocol in advance of conducting this review [24]. We did not apply any language exclusions, unlike other recent reviews which were limited to primary studies published in the English language only [10,12–14,58].

We were able to draw on more recent primary studies compared with older systematic reviews [7,8,10,12,18], which was especially relevant given the increasing emphasis on remote triage since the COVID-19 pandemic. Studies published from 1998 to June 2023 were included, meaning that 25 years of

research were covered and that relevant earlier studies would not be missed by a more restricted search period [10,13].

Our criteria relating to safety outcomes were also strict with only objective indicators eligible and perceived safety outcomes not included. Finally, we also excluded studies involving a triage line operating within primary care only and not referring to emergency departments.

Given all of the differences detailed above, it was not possible to meaningfully compare our review to previous reviews.

4.2.2 Comparison with guidelines

4.2.2.1 Understanding measures of safe and effective triage

There are two important screening measures when allocating emergency care, and these are sensitivity and specificity.

The sensitivity of a screening or diagnostic test is the probability of testing positive (or identifying a case) if the disease is truly present [35]. Sensitivity is related to undertriage. Undertriage is defined as a triage decision that classifies patients at a lower disposition/urgency level than what was needed. Undertriage is the portion of true positives missed by the triage screening process and who are sent to a lower level of care than they should be. Undertriage is an important standard measure of accuracy.

The specificity of a screening or diagnostic test is the probability of testing negative (or no disease being present) [35]. Specificity is related to overtriage. Overtriage is defined as a triage decision that classifies patients at a higher disposition/urgency level than what was needed, and is calculated as the number of calls known to be triaged with higher priority than needed as a proportion of all calls (or as a proportion of all calls within a given triage disposition level). It is the proportion of true negatives misclassified by the triage screening process as positive and sent to a higher level of care than they should be, and is an important standard measure of effectiveness.

Undertriage is a proxy measure of the increased risk of possible negative outcomes due to delays in treatment, and overtriage is a proxy measure for ineffectiveness due to unnecessary resource utilisation and overcrowding. However, a balance between the two is required.

The American College of Surgeons Committee on Trauma provides guidelines that state that an undertriage rate of less than 5% and an overtriage rate of 25–35% should be considered acceptable target levels [59]. We used this guideline when evaluating the findings of our review in relation to general triage services, as there is little other guidance in the literature on how to interpret general triage results [60].

4.2.2.2 American College of Surgeons Committee on Trauma guidelines

Given all the differences between our review and others as outlined in Section 4.2.1, our review was not directly comparable with the series of other reviews we read on remote triage [7,8,10,12–16,19,21,23,57,61]. We therefore made the decision to instead compare the results of our review with the target levels of the American College of Surgeons Committee on Trauma [59].

Six of the 14 included studies provided data on the number of calls triaged at all triage disposition levels, including ambulance, thus allowing the extraction of overall undertriage and overtriage rates comparable with an acceptable target level [42,43,45–47,52]. Two of these studies reported on general samples [47,52] rather than on calls relating to specific types of symptoms.

In the case of the Lewis *et al.* study, which analysed all NHS 111 callers in the Yorkshire and Humber regions of the UK, undertriage rates were implied by admissions within 3 days among those triaged to below the need for an ambulance and presentation to the ED (4.2%), and by the proportion of those

triaged to below the need for an ambulance and presentation to the ED who presented to the ED within 2 days and were not classed as non-urgent (9.6%). Based on the rate of admissions, this service therefore met the guideline of an undertriage rate of less than 5%. Based on assessment of urgency alone, however, this service did not meet the target undertriage level of less than 5%. This indicator may however be of less importance given the guideline describes indicators as death, admission, or being taken to intensive care or an operating room [59]. Therefore, merely being assessed as not non-urgent may not meet the threshold for undertriage according to this guideline. Overtriage in the same study was implied by the number of calls triaged to ambulance or ED who were later classed as non-urgent. At 6.6%, this was well below the target level of 25–35% [52].

In the case of the Graversen *et al.* study, which analysed calls to an out-of-hours primary care line in Denmark, clinically relevant undertriage and overtriage rates were reported based on assessment with a validated tool. In the random sample of general calls, rates of 5.5% clinically relevant undertriage and 6.7% clinically relevant overtriage were reported, meaning that this service was above the target of less than 5% undertriage but well below the target level of 25–35% overtriage. Importantly however this study did not report triage dispositions. Undertriage and overtriage rates were calculated as proportions of all calls rather than as proportions of calls triaged to low and high dispositions as the reference guideline instructs [59] and therefore the utility of this comparison is not clear.

Three of the four studies examining calls relating to specific symptoms reported outcomes that allowed for extraction of undertriage and overtriage rates based on the final diagnosis [45,46] or assessment at hospital, and/or admissions [42]. We searched for guideline undertriage and overtriage rates specific to these conditions (transient ischaemic attack or stroke, and acute coronary artery syndrome) and symptoms (chest pain in young adults), but these conditions were not included in the guidelines by the American College of Surgeons Committee on Trauma.

4.3 Strengths and limitations

We designed a detailed protocol based on the research questions and the conduct of other systematic reviews on remote triage. One limitation of our protocol was that we did not anticipate the paucity of RCTs and were very dependent on surveillance system studies; therefore, control for confounding factors is limited. Following the publication of the protocol but before the commencement of title and abstract screening, the research team decided that cohort and case-control study designs should be excluded. This decision was informed by extensive discussions among the research team and was ultimately justified by the need to synthesise higher-quality research in order to inform policy-makers in this area. However, a number of studies that defined themselves as cohort studies and one cross-sectional study were included, as they met the HRB's definition of a surveillance system study. While surveillance system studies are technically a form of cohort study, they are population-based and involve applied interventions as opposed to regular cohort studies which examine exposures and would therefore introduce severe self-selection bias. We made a number of changes to the protocol in order to increase the number of studies that we could include. For example, we reduced the minimum age of the study population from 18 to 16 years in line with current national guidelines for adult emergency services in Ireland. Additionally, once the research team began full-text screening, several studies included mixed adult and paediatric populations. In some cases, it was not possible to separate the sample by age, so we decided that if we could discern that 75% or more of a study sample was aged 16 years and over, the study would be included in this systematic review. In our protocol we did not intend to include studies that did not have a comparator, but due to the paucity of evidence, we retained outcomes that were reported by triage disposition level, although strictly speaking they had no comparator. In relation to quality assessment using the National Heart, Lung, and Blood Institute (NHLBI) tool for observational cohort and cross-

sectional studies, critical domains were not specified in the protocol. Rather, critical domains most relevant to surveillance systems were identified in the well-respected *Epidemiology in Medicine* reference book [35] as we classified particular observational studies as such.

The methodology employed for the searches for Questions 1 and 2 were carefully considered, with the intention of capturing all relevant studies that would best answer these two systematic review questions for use by policy-makers and service planners in Ireland. The principal strengths of these searches is that they were expert, comprehensive searches; they were conducted across a range of relevant, highly regarded databases and sources; and they employed best practice methods, all of which strengthens the validity of the search results. Staging the searches in order to meet the process of the review – scoping, conducting the main database searches, conducting the supplementary and grey literature searches, conducting the reference and citation chasing searches, and conducting the final date-specific database searches – provided a full indication of the available evidence.

A number of the included surveillance system studies were classified as having significant data linkage issues based on our quality assessment (e.g. invalid patient identifiers), and these were sometimes defined by the primary study authors as exclusion criteria rather than as loss to follow-up or missing data [45,46,48–50]. The proportion of unlinkable records or missing data reported overall ranged from 0.4% to 47% [39,41–52]. In two studies, the number [45] or total number [46] of calls for which data were lost due to the GP's refusal to provide a final diagnosis was unknown.

One of the major limitations of our review was that we could not pool outcome data, as the study populations, triage models, outcomes assessed, and follow-up periods were very different across studies. Where possible, we have made narrative comments on patterns across studies reporting outcomes for the same follow-up period. This was only done where studies were similar (e.g. differing only on the type of staff conducting triage), apart from the triage disposition outcome, which was compared across all studies reporting on the number of calls triaged to below ED level in order to reflect ED avoidance rates across services studied. In addition to the differences in triage models and study populations, the included studies were also conducted in eight different countries meaning another layer of heterogeneity is present in this review, in relation to the wider health service contexts in which the triage services were operating.

Given between-study differences with respect to specific subpopulations, outcome assessment, and follow-up periods, it was also not possible to fully comment on patterns in relation to subgroups of interest as listed in the protocol (i.e. particular patient populations, clinical governance models, organisational level, and involvement of technology). Moreover, in relation to triage service modes, only studies based on telephone triage were identified. Several studies did, however, report on within-study differences relating to clinical governance models and the use of technology. None of the included studies adjusted for chronological trends in ED attendance, and since meta-analysis was not possible, we were also unable to examine data based on time of day, day of the week, and year-on-year trends. One of the included studies did comment on chronological trends within its own analysis of NHS 111 calls [52]. The included primary studies were based in eight countries across three continents (Appendix F). Some analyses were based on unique individuals, while others were based on calls (Appendix F).

4.4 Future research

The term 'triage' comes from the French '*trier*', which means to separate or to choose. Triage is the process of selecting for care or treatment those of highest priority, or, when resources are limited, those thought most likely to benefit from care or treatment. It is classified as a form of screening to select those most in need of emergency or urgent care and allocate others to a more appropriate but less resource-

intensive form of care, such as out-of-hours GP consultation, routine GP visit, or where appropriate self-care.

As mentioned in Section 4.2.2.1, the American College of Surgeons Committee on Trauma states that an undertriage rate of less than 5% and an overtriage rate of 25–35% should be considered acceptable target levels for general triage services [59]. There is little other guidance in the literature on how to interpret general triage results, and this is an area for further study, so we recommend that this guidance be used in order to evaluate population-based remote general triage systems. In addition, there is no guidance on acceptable undertriage and overtriage rates for symptom- or disease-specific triage services, and these need to be developed.

Only one of the studies examining general triage services completed an analysis based on all callers in a population [52], and these are the types of general triage studies required if we are to compare and learn from different systems, develop acceptable undertriage and overtriage norms, and truly understand the safety, accuracy, and effectiveness of a remote triage system. Further surveillance system type studies which include all callers are therefore needed. This will be more useful than studies which only examine follow-up outcomes for subgroups, based on certain triage dispositions, symptoms or conditions, and thus obscure knowledge of overall accuracy and prevent comparison of services. These whole system studies may also help with the further establishment of overall reference standards for acceptable undertriage and overtriage rates. In relation to safety outcomes, objective indicators, in the form of mortality and final diagnoses (of conditions a triage line had ruled in or out), may introduce less bias than outcomes related to admissions which may be more likely to occur based on patients presenting at ED rather than due to acuity alone. For effectiveness it is important to capture triage dispositions and actual ED attendance. Follow-up healthcare use beyond ED attendance would also however be valuable to capture, where possible, in order to provide a full picture of the resource use implications of remote pre-hospital triage.

Finally, future studies analysing system data should also, where data is available, conduct sensitivity analysis based on language and culture to see whether language and cultural characteristics of callers play a role in the safety and effectiveness of the triage service they receive.

5 Conclusions

Based on the American College of Surgeons Committee on Trauma guidelines [59], we found very low-certainty and mixed evidence that remote general triage services are safe, as well as very low-certainty evidence that these services are effective. We found very low-certainty evidence that specific remote triage services are safe and effective, but no reference guidelines for comparison were available for the specific conditions or symptoms covered in our included studies on specific triage services. Based on this review, we cannot say that remote triage services are not safe or effective, as the design and conduct of the included studies are not adequate to establish their safety and effectiveness with moderate or high certainty. Therefore, we need large, high-quality studies on complete general triage systems covering all triage dispositions, and the undertriage and overtriage outcomes need to be compared with established guidelines or acceptable target levels. Our specific findings cannot be directly compared with existing systematic reviews, although the existing reviews also reported uncertain and mixed findings.

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Appendices

Appendix A PRISMA and SWiM checklists

PRISMA checklist

Section and topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	Title page
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	Executive Summary
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	Section 1.2
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	Section 1.3
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	Section 2.2
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	Section 2.3.3
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	Appendix B
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	Section 2.4
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any	Section 2.5

Section and topic	Item #	Checklist item	Location where item is reported
		processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	Sections 2.2 and 2.5
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	Section 2.5
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	Section 2.6
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	Section 2.7.4
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	Section 2.7.3, Appendix G
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	Section 2.7.
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	Section 2.7

Section and topic	Item #	Checklist item	Location where item is reported
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	Section 2.7
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	Sections 2.7.3 and 3.3
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	Section 2.7.4
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	Section 2.6
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	Section 2.7.5
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	Section 3.1
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	Appendix C
Study characteristics	17	Cite each included study and present its characteristics.	Appendix F
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	Appendix D and E
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimate and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	Section 3.7

Section and topic	Item #	Checklist item	Location where item is reported
Results of syntheses	20a	For each synthesis, briefly summarise the characteristics and risk of bias among contributing studies.	Section 3.7
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	Not applicable as no statistical syntheses were possible
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	Section 3.7
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	Not applicable
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	Section 3.7, Appendices D and E
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	Section 3.7, Appendix H
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	Section 4.2
	23b	Discuss any limitations of the evidence included in the review.	Section 4.3
	23c	Discuss any limitations of the review processes used.	Section 4.3
	23d	Discuss implications of the results for practice, policy, and future research.	Section 4.4 and 5
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	Section 2.1

Section and topic	Item #	Checklist item	Location where item is reported
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	Section 2.1
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	Sections 2.2 and 2.8
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	Not applicable
Competing interests	26	Declare any competing interests of review authors.	Not applicable
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	Not reported

SWiM checklist

SWiM reporting item	Item description	Page in manuscript where item is reported	Other*
Methods			
1 Grouping studies for synthesis	1a) Provide a description of, and rationale for, the groups used in the synthesis (e.g., groupings of populations, interventions, outcomes, study design)	Page 39	
	1b) Detail and provide rationale for any changes made subsequent to the protocol in the groups used in the synthesis	Page 41–42	
2 Describe the standardised metric and transformation methods used	Describe the standardised metric for each outcome. Explain why the metric(s) was chosen, and describe any methods used to transform the intervention effects, as reported in the study, to the standardised metric, citing any methodological guidance consulted	Not applicable as the majority of studies provided frequencies or percentages only with no extraction of standardised metrics possible	
3 Describe the synthesis methods	Describe and justify the methods used to synthesise the effects for each outcome when it was not possible to undertake a meta-analysis of effect estimates	Page 39–40	
4 Criteria used to prioritise results for summary and synthesis	Where applicable, provide the criteria used, with supporting justification, to select the particular studies, or a particular study, for the main synthesis or to draw conclusions from the synthesis (e.g., based on study design, risk of bias assessments, directness in relation to the review question)	Not applicable	
5 Investigation of heterogeneity in reported effects	State the method(s) used to examine heterogeneity in reported effects when it was not possible to undertake a meta-analysis of effect estimates and its extensions to investigate heterogeneity	Page 40–41	
6 Certainty of evidence	Describe the methods used to assess certainty of the synthesis findings	Page 40–41	
7 Data presentation methods	Describe the graphical and tabular methods used to present the effects (e.g., tables, forest plots, harvest plots). Specify key study characteristics (e.g., study design, risk of bias) used to order the studies, in the text and any tables or graphs, clearly referencing the studies included	Page 40	
Results			

SWiM reporting item	Item description	Page in manuscript where item is reported	Other*
8 Reporting results	For each comparison and outcome, provide a description of the synthesised findings, and the certainty of the findings. Describe the result in language that is consistent with the question the synthesis addresses, and indicate which studies contribute to the synthesis	Page 47–113	
Discussion			
9 Limitations of the synthesis	Report the limitations of the synthesis methods used and/or the groupings used in the synthesis, and how these affect the conclusions that can be drawn in relation to the original review question	Page 123–124	

Appendix B Database literature searches

Search table

Resource	Search date	Results
1. Primary searches	**09-11 Jun 2023**	
BASE: Bielefeld Academic Search Engine	11 Jun 2023	407
Cochrane Library/CENTRAL (Wiley)	10 Jun 2023	Total 1,745 of which, exported 1,744 (Exported: Reviews 65, Trials 1,679. Not exported or required: Special collections 1)
EBSCO CINAHL	09 Jun 2023	2,115
EBSCO MEDLINE	09 Jun 2023	4,974
EBSCO SocINDEX with Full Text	09 Jun 2023	115
Embase.com	11 Jun 2023	6,484
International HTA database (inHTA)	10 Jun 2023	311
Lenus	10 Jun 2023	31
LILACS	10 Jun 2023	1,338
medRxiv/bioRxiv	11 Jun 2023	120
OPENGrey via DANS	11 Jun 2023	31
Osf.io	11 Jun 2023	23
Ovid PsycINFO	09 Jun 2023	703
Research Square	11 Jun 2023	99
Total results		14,676
Deduplicated results/results uploaded to EPPI-Reviewer Web		10,687
2. Supplemental searches	**13-27 Oct 2023**	
Clinicaltrials.gov	13 Oct 2023	67
DuckDuckgo.com	13 Oct 2023	340
Epistemonikos	13 Oct 2023	859
Google Scholar	13 Oct 2023	159
SciELO	13 Oct 2023	328

EBSCO MEDLINE	13 Oct 2023	405
Citation chasing	19-20 Oct 2023	1,274
Reference chasing	20-26 Oct 2023	1,136
Protocol chasing	26-27 Oct 2023	85
Total results		4,654
Deduplicated results/results uploaded to EPPI-Reviewer Web		3,707

Search strategies: Primary searches

BASE: Bielefeld Academic Search Engine

Database/resource: BASE: Bielefeld Academic Search Engine
Platform: https://www.base-search.net/Search/Advanced
Search date: 11 Jun 2023

1	subj:triage subj:remote	45
2	subj:teletriage	9
3	subj:telereferral	0
4	tit:triage AND tit:remote	123
5	tit:teletriage	32
6	Tit:telereferral	2
7	subj:triage subj:prehospital	158
8	subj:teleconsultation AND subj:prehospital	5
9	subj:triage AND subj:phone	14
10	subj:triage AND subj:online	19
	Total	407

Cochrane Library/CENTRAL (Wiley)

Database/resource: Cochrane Library including Cochrane Database of Systematic Reviews (CDSR) and Cochrane Central Register of Controlled Trials (CENTRAL)

Platform: Wiley
Search date: 10 Jun 2023

	ID Search Hits	
#1	MeSH descriptor: [Triage] explode all trees	403
#2	(Triage* OR triaging OR “self-triage” OR triageur* OR triagist* OR “traige”)	2,480
#3	(Teletriag* OR “Tele-triage” OR “phone-triage” OR “e-triage”)	8
#4	(telerefer* OR “tele-referral” OR “tele-emergency” OR “tele-emergencies” OR “e-referral”)	186
#5	(“tele-consultation” OR “tele-consulted” OR “tele-consulting” OR teleconsult*):ti,ab,kw	853
#6	(Undertriag* OR overtriag* OR “under-triage” OR “under-triaged” OR “over-triage” OR “over-triaged” OR mistriag* OR “mis-triage” OR “mis-triaged”)	41
#7	MeSH descriptor: [After-Hours Care] explode all trees	44
#8	MeSH descriptor: [Answering Services] explode all trees	3
#9	MeSH descriptor: [Referral and Consultation] explode all trees	3,006
#10	(remote OR distant OR distance OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”):ti,ab,kw	42,066
#11	#9 AND #10	520
#12	((“patient evaluation” OR “patient assessment” OR “patient screening”) AND (remote OR distant OR distance OR “off-campus” OR “off-site”)):ti,ab,kw	85

#13	(“decision support system” OR “decision support systems” OR “symptom checker” OR “symptom checkers”):ti,ab,kw	2,082
#14	MeSH descriptor: [Decision Support Systems, Clinical] explode all trees	560
#15	(“patient referral” AND (remote OR distance OR distant OR “off-campus” OR “off-site”)):ti,ab,kw	121
#16	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #11 OR #12 OR #13 OR #14 OR #15	6,158
#17	MeSH descriptor: [Remote Consultation] explode all trees	440
#18	((Remote* OR distance OR distant OR “off-site” OR “off-campus”) NEXT (consult* OR refer* OR assess* OR screen*)):ti,ab,kw	656
#19	MeSH descriptor: [Telemedicine] explode all trees	4,228
#20	((remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)):ti,ab,kw	280,885
#21	#19 AND #20	1,906
#22	MeSH descriptor: [Telecommunications] this term only	106
#23	#22 AND #20	26
#24	MeSH descriptor: [Hotlines] explode all trees	195
#25	MeSH descriptor: [Call Centers] explode all trees	6
#26	((helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines” OR “call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”)):ti,ab,kw	839
#27	MeSH descriptor: [Telephone] explode all trees	6,094
#28	MeSH descriptor: [Computing Methodologies] explode all trees	28,503
#29	MeSH descriptor: [Mobile Applications] explode all trees	1,552
#30	MeSH descriptor: [Social Media] explode all trees	568
#31	MeSH descriptor: [Electronic Mail] explode all trees	408
#32	(#27 OR #28 OR #29 OR #30 OR #31)	33,093
#33	#32 AND #20	6,012
#34	(telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*):ti,ab,kw	46,791
#35	(“computer-assisted” OR computerised OR computerized OR “Computerised Decision Support”):ti,ab,kw	10,784
#36	(digital OR online OR internet OR web OR wifi OR “wi-fi” OR wireless OR virtual):ti,ab,kw	68,048
#37	(“text message” OR “text messages” OR “text-messages” OR “text messaging” OR “text-messaging” OR texting OR SMS OR “instant message” OR “instant messages” OR “instant messaging”):ti,ab,kw	7,362
#38	(software OR app OR apps OR email OR “e-mail” OR “electronic mail” OR multimedia):ti,ab,kw	47,305
#39	(“e-health” OR ehealth OR “m-health“ OR mhealth OR “mobile health”):ti,ab,kw	4,613
#40	((Telecommunicat* OR “tele-communication” OR telecom OR telehealth OR Telemedicin* OR Telenurs* OR Telerehabil* OR “tele-health” OR “tele-medicine” OR “tele-nursing” OR “tele-rehabilitation”)):ti,ab,kw	9,853
#41	#34 OR #35 OR #36 OR #37 OR #38 OR #39 OR #40	152,952
#42	#41 AND #20	38,286
#43	#17 OR #18 OR #21 OR #23 #24 OR #25 OR #26 OR #33 OR #42	40,861

#44	#43 AND #16 with Cochrane Library publication date Between Jan 1997 and Dec 2023	1,745
	Of which 65 reviews, 1679 trials and 1 special collection (not exportable – collection of already published reviews))	
	Exported	1,744

EBSCO MEDLINE

Database/resource: MEDLINE

Platform: EBSCO

Search date: 11 Jun 2023

Search line	Search terms	Results
S1	(MH "Triage") OR (TI (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige")) OR (AB (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige")) OR (SU (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige"))	32,835
S2	(TI (Undertriag* OR overtriag* OR "under-triage" OR "under-triaged" OR "over-triage" OR "over-triaged" OR mistriag* OR "mis-triage" OR "mis-triaged" OR Teletriag* OR "Tele-triage" OR "phone-triage" OR "e-triage" OR "e-referral" OR telerefer* OR "tele-referral" OR "tele-emergency" OR "tele-emergencies")) OR (AB (Undertriag* OR overtriag* OR "under-triage" OR "under-triaged" OR "over-triage" OR "over-triaged" OR mistriag* OR "mis-triage" OR "mis-triaged" OR Teletriag* OR "Tele-triage" OR "phone-triage" OR "e-triage" OR "e-referral" OR telerefer* OR "tele-referral" OR "tele-emergency" OR "tele-emergencies")) OR (SU (Undertriag* OR overtriag* OR "under-triage" OR "under-triaged" OR "over-triage" OR "over-triaged" OR mistriag* OR "mis-triage" OR "mis-triaged" OR Teletriag* OR "Tele-triage" OR "phone-triage" OR "e-triage" OR "e-referral" OR telerefer* OR "tele-referral" OR "tele-emergency" OR "tele-emergencies"))	1,161
S3	((MH "After-Hours Care+") OR (MH "Answering Services")) AND ((TI (screening OR assess* OR stratif* OR priorit* OR referral OR filter* OR evaluat* OR categoris* OR categoriz* OR decision*)) OR (AB (screening OR stratif* OR prioritis* OR prioritiz* OR referral OR filter* OR evaluat* OR categoris* OR categoriz* OR decision*)))	633
S4	((TI (prescreen* OR "pre-screening" OR "pre-assessment" OR preassess* OR "pre-evaluation" OR "patient referral" OR "referral threshold" OR "ED screening" OR "emergency screening" OR "patient prioritisation" OR "prioritisation of patients" OR "patient prioritization" OR "prioritization of patients" OR "ED streaming" OR "priority system" OR "priority systems" OR "patient stratification")) OR (AB (prescreen* OR "pre-screening" OR "pre-assessment" OR preassess* OR "pre-evaluation" OR "patient referral" OR "referral threshold" OR "ED screening" OR "emergency screening" OR "patient prioritisation" OR "prioritisation of patients" OR "patient prioritization" OR "prioritization of patients" OR "ED streaming" OR "priority system" OR "priority systems" OR "patient stratification")))	9,932
S5	(MH "Referral and Consultation") AND ((TI (Assess* OR evaluat* OR screen* OR priorit*)) OR (AB (Assess* OR evaluat* OR screen* OR priorit*)))	27,599
S6	((MH "Decision Support Systems, Clinical") OR ((TI ("Decision support system" OR "decision support systems" OR "symptom checker" OR "symptom checkers")) OR (AB ("Decision support system" OR "decision support systems" OR "symptom checker" OR "symptom checkers"))))	14,189
S7	S4 OR S5 OR S6	51,264
S8	((TI (remote OR distant OR distance OR prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR "emergency care" OR "urgent care" OR	500,549

	"unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")) OR (AB (remote OR distance OR distant prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR "emergency care" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")) OR (SU (remote OR distant OR distance OR prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR "emergency care" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")))	
S9	S7 AND S8	1,969
S10	(TI ((prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-emergency" OR "urgent care" OR "unscheduled care" OR "emergency care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "time-critical") N2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter* OR consult*))) OR (AB ((prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-emergency" OR "urgent care" OR "unscheduled care" OR "emergency care" OR "out-of-hours" OR "out of hours" OR "after-hours" OR "after hours" OR "time-critical") N2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter*)))	398
S11	TI ("tele-consultation" OR "tele-consulted" OR "tele-consulting" OR teleconsult*) OR AB ("tele-consultation" OR "tele-consulted" OR "tele-consulting" OR teleconsult*) OR SU ("tele-consultation" OR "tele-consulted" OR "tele-consulting" OR teleconsult*)	2,349
S12	((TI ("preliminary assessment" OR "preliminary screening")) OR (AB ("preliminary assessment" OR "preliminary screening")) OR (SU ("preliminary assessment" OR "preliminary screening"))) AND ((TI (GP OR "general practice" OR "general practitioner" OR "general practitioners" OR "primary care" OR doctor* OR nurse* OR "nursing" OR midwif* OR midwives OR clinician* OR responder* OR dispatch*)) OR (AB (GP OR "general practice" OR "general practitioner" OR "general practitioners" OR "primary care" OR doctor* OR nurse* OR "nursing" OR midwif* OR midwives OR clinician* OR responder* OR clinician* OR dispatch*)))	197
S13	(MH "Emergency Medical Service Communication Systems") AND ((MH "Referral and Consultation") OR ((TI refer* OR screen* OR priorit*) OR (AB refer* OR screen* OR priorit*)))	233
S14	(TX (triaje OR triaj OR triyaj OR "trijaža" OR "triaaž" OR "triažas" OR "triaža" OR triase OR "διαλογή" OR bambanta OR "osztályozás" OR "þrígang" OR smistamento OR "šķirošana" OR whakawai OR prioritering OR "ocena stanu zdrowia rannych" OR "сортировка" OR "சாதனை" OR "ट्राइएज" OR "분류" OR "分流" OR "การทดสอบ" OR "ტრიაჟი" OR "トリアージ"))	493
S15	S1 OR S2 OR S3 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14	38,349
S16	(MH "Remote consultation+")	5,785
S17	((MH "Telemedicine+") OR (MH "Telecommunications") OR (MH "Telephone+") OR (MH "Computing Methodologies") OR (MH "Mobile applications") OR (MH "Social Media") OR (MH "Electronic Mail"))	103,424
S18	((TI ("computer-assisted" OR computerised OR computerized OR "Computerised Decision Support" OR software OR app OR apps OR email OR "e-mail" OR "electronic mail" OR multimedia OR digital OR online OR internet OR web OR wifi OR "wi-fi" OR wireless OR virtual)) OR (AB("computer-assisted" OR computerised OR computerized OR "Computerised Decision Support" software OR app OR apps OR email OR "e-mail" OR "electronic mail" OR multimedia OR online OR internet OR web OR wifi OR "wi-fi" OR wireless OR virtual)))	744,998

S19	(TI (“e-health” OR ehealth OR “m-health” OR mhealth OR “mobile health”)) OR (AB (“e-health” OR ehealth OR “m-health” OR mhealth OR “mobile health”)) OR (SU (“e-health” OR ehealth OR “m-health“ OR mhealth OR “mobile health”)) OR (MW (“e-health” OR ehealth OR “m-health“ OR mhealth OR “mobile health”))	26,790
S20	((TI (“text message” OR “text messages” OR “text-messages” OR “text messaging” OR “text-messaging” OR texting OR SMS OR “instant message” OR “instant messages” OR “instant messaging”)) OR (AB (“text message” OR “text messages” OR “text-messages” OR “text messaging” OR “text-messaging” OR texting OR SMS OR “instant message” OR “instant messages” OR “instant messaging”)))	13,841
S21	((TI (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*)) OR (AB (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*)) OR (SU (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*))	158,443
S22	(TI (Telecommunicat* OR “tele-communication” OR telecom OR telehealth OR Telemedicin* OR Telenurs* OR Telerehabil* OR “tele-health” OR “tele-medicine” OR “tele-nursing” OR “tele-rehabilitation”)) OR (AB (Telecommunicat* OR “tele-communication” OR telecom OR telehealth OR Telemedicin* OR Telenurs* OR Telerehabil* OR “tele-health” OR “tele-medicine” OR “tele-nursing” OR “tele-rehabilitation”))	34,884
S23	S17 OR S18 OR S19 OR S20 OR S21 OR S22	938,002
S24	((TI (remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)))	1,033,785
S25	S23 AND S24	74,883
S26	(TI (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”)) OR (AB (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”)) OR (SU (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”))	4,908
S27	(TI (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”)) OR (AB (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”)) OR (SU (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”))	1,126
S28	(MH “Hotlines”) OR (MH “Call Centers”)	3,064
S29	(TI ((Remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*))) OR (AB ((remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*))) OR (SU ((remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*)))	12,851
S30	S16 OR S25 OR S26 OR S27 OR S28 OR S29	88,611
S31	S15 AND S30	5,139
S32	S15 AND S30 Limiters - Date of Publication: 19970101-20231231	4,974

EBSCO CINAHL

Database/resource: CINAHL

Platform: EBSCO

Search date: 09 Jun 2023

S1	(MH “Triage Nursing”) OR (MH “Triage (Iowa NIC)”) OR (MH “Telephone Triage Nursing”) OR (MH “Triage Nurses”) OR (MH “Triage”)	11072
S2	(TI (Triage* OR triaging OR “self-triage” OR triageur* OR triagist* OR “traige”)) OR (AB (Triage* OR triaging OR “self-triage” OR triageur* OR triagist* OR “traige”)) OR (SU (Triage* OR triaging OR “self-triage” OR triageur* OR triagist* OR “traige”))	18634
S3	(TX (Teletriag* OR “Tele-triage” OR “phone-triage” OR “e-triage”))	125
S4	(TX (telerefer* OR “tele-referral” OR “tele-emergency” OR “tele-emergencies” OR “e-referral”))	58
S5	(TX (“tele-consultation” OR “tele-consulted” OR “tele-consulting” OR teleconsult*))	758
S6	(TX (Undertriag* OR overtriag* OR “under-triage” OR “under-triaged” OR “over-triage” OR “over-triaged” OR mistriag* OR “mis-triage” OR “mis-triaged”))	557
S7	((TI (“patient evaluation” OR “patient assessment” OR “patient screening”)) OR (AB (“patient evaluation” OR “patient assessment” OR “patient screening”))) AND ((TI (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”)) OR (MW (prehospital* OR “pre-hospital” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “pre-ED” OR “pre-emergency” OR “time-critical”)) OR (SU (prehospital* OR “pre-hospital” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “pre-ED” OR “pre-emergency” OR “time-critical”)))	106
S8	((TI (“patient evaluation” OR “patient assessment” OR “patient screening”)) OR (AB (“patient evaluation” OR “patient assessment” OR “patient screening”))) AND ((TI remote) OR (AB remote))	38
S9	((MH “prehospital care”)) AND ((TI (screening OR assess* OR stratif* OR priorit* OR referral OR refer OR filter* OR consult* OR evaluat* OR categoris* OR categoriz* OR decision*)) OR (AB (screening OR stratif* OR prioritis* OR prioritiz* OR referral OR refer OR filter* OR consult* OR evaluat* OR categoris* OR categoriz* OR decision*)))	2256
S10	(MH “Referral and Consultation”) AND ((TI (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “out-of- hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”)) OR (MW (prehospital* OR “pre-hospital” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “pre-ED” OR “pre-emergency” OR “time-critical”)) OR (SU (prehospital* OR “pre-hospital” OR “urgent care” OR	428

	"unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")))	
S11	(MH "Referral and Consultation") AND ((TI (remote OR distant OR distance) OR (AB (remote OR distant OR distance)))	616
S12	((TI (prescreen* OR "pre-screening" OR "pre-assessment" OR preassess* OR "pre-evaluation")) OR (AB (prescreen* OR "pre-screening" OR "pre-assessment" OR preassess* OR "pre-evaluation" OR "pre-evaluated")) OR (SU (prescreen* OR "pre-screening" OR "pre-assessment" OR preassess* OR "pre-evaluation" OR "pre-evaluated"))) AND ((TI (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "time-critical") OR (AB (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "time-critical")))	214
S13	((TI (prescreen* OR "pre-screening" OR "pre-assessment" OR preassess* OR "pre-evaluation")) OR (AB (prescreen* OR "pre-screening" OR "pre-assessment" OR preassess* OR "pre-evaluation" OR "pre-evaluated")) OR (SU (prescreen* OR "pre-screening" OR "pre-assessment" OR preassess* OR "pre-evaluation" OR "pre-evaluated"))) AND ((TI (GP OR "general practice" OR "general practitioner" OR "general practitioners" OR "primary care" OR doctor* OR nurse* OR "nursing" OR midwif* OR midwives OR clinician* OR responder* OR dispatch*)) OR (AB (GP OR "general practice" OR "general practitioner" OR "general practitioners" OR "primary care" OR doctor* OR nurse* OR "nursing" OR midwif* OR midwives OR clinician* OR responder* OR clinician* OR dispatch*)))	240
S14	(TI ((prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-emergency" OR "urgent care" OR "unscheduled care" OR "emergency care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "time-critical") N2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter* OR consult*))) OR (AB ((prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-emergency" OR "urgent care" OR "unscheduled care" OR "emergency care" OR "out-of-hours" OR "out of hours" OR "after-hours" OR "after hours" OR "time-critical") N2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter*)))	235
S15	(MH "Emergency Medical Service Communication Systems") AND ((MH "Referral and Consultation") OR ((TI refer* OR Screen* OR priorit*) OR (AB refer* OR screen* OR priorit*)))	194
S16	((TI ("patient referral" OR "referral threshold" OR "patient screening" OR "ED screening" OR "emergency screening" OR "patient prioritisation" OR "prioritisation of patients" OR "patient prioritization" OR "prioritization of patients" OR "ED streaming" OR "priority system" OR "priority systems" OR "patient stratification")) OR (AB ("patient referral" OR "referral threshold" OR "patient screening" OR "ED screening" OR "emergency screening" OR "patient prioritisation" OR "prioritisation of patients" OR "patient prioritization" OR "prioritization of patients" OR "ED streaming" OR "priority system" OR "priority systems" OR "patient stratification")) OR (SU ("referral threshold" OR "ED screening" OR "patient screening" OR "emergency screening" OR "patient prioritisation" OR "prioritisation of patients" OR "patient prioritization" OR "prioritization of patients" OR "ED streaming" OR "priority system" OR "priority systems" OR "patient stratification"))) AND ((TI (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR	466

	"urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")) OR (AB (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "time-critical")) OR (SU (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")))	
S17	((MH "Decision Support Systems, Clinical") OR ((TI ("Decision support system" OR "decision support systems" OR "symptom checker" OR "symptom checkers")) OR (AB ("Decision support system" OR "decision support systems" OR "symptom checker" OR "symptom checkers")))) AND ((TI (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR "urgent care" OR "unscheduled care" OR "emergency care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "time-critical")) OR (AB (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR "emergency care" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")))	109
S18	(TX (triaje OR triaj OR triyaj OR "trijaža" OR "triaaž" OR "triažas" OR "triaža" OR triase OR "διαλογή" OR bambanta OR "osztályozás" OR "þrígang" OR smistamento OR "šķirošana" OR whakawai OR prioritering OR "ocena stanu zdrowia rannych" OR "сортировка" OR "சோதனை" OR "ट्राइएज" OR "분류" OR "分流" OR "การทดสอบ" OR "ತ್ರಿಯಜ" OR "トリアージ"))	199
S19	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15 OR S16 OR S17 OR S18	23548
S20	(MH "Remote consultation+")	3084
S21	(TI ((Remote* OR distance OR distant OR "off-site" OR "off-campus") N2 (consult* OR refer* OR assess* OR screen*))) OR (AB ((remote* OR distance OR distant OR "off-site" OR "off-campus") N2 (consult* OR refer* OR assess* OR screen*))) OR (MW ((remote OR distance OR distant OR "off-site" OR "off-campus") N2 (consult* OR refer* OR assess* OR screen*))) OR (SU ((remote* OR distance OR distant OR "off-site" OR "off-campus") N2 (consult* OR refer* OR assess* OR screen*)))	4928
S22	((MH "Telemedicine") OR (MH "Telenursing")) AND ((TI (remote* OR distant OR distance OR "off-site" OR "off-campus" OR prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")) OR (AB (remote* OR distant OR distance OR "off-site" OR "off-campus" OR prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")))	5171
S23	(MH "Telecommunications+") AND ((TI (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")) OR (AB (prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital*	14392

	OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)))	
S24	((TI (Telecommunicat* OR “tele-communication” OR telecom OR telehealth OR Telemedicin* OR Telenurs* OR Telerehabil* OR “tele-health” OR “tele-medicine” OR “tele-nursing” OR “tele-rehabilitation”)) OR (AB (Telecommunicat* OR “tele-communication” OR telecom OR telehealth OR Telemedicin* OR Telenurs* OR Telerehabil* OR “tele-health” OR “tele-medicine” OR “tele-nursing” OR “tele-rehabilitation”))) AND ((TI (remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)))	5899
S25	(MH “Internet”) AND ((TI (remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)))	3959
S26	(TI (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”)) OR (AB (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”)) OR (SU (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”))	2474
S27	(TI (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”)) OR (AB (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”)) OR (SU (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”))	796
S28	(MH “Telephone+”) AND ((TI (remote* OR distant OR Distance OR “off-campus” OR “off-site” OR offsite” OR prehospital* OR “pre-hospital” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “pre-ED” OR “pre-emergency” OR “time-critical”)) OR (AB (remote* OR distant OR Distance OR “off-campus” OR “off-site” OR offsite” OR prehospital* OR “pre-hospital” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “pre-ED” OR “pre-emergency” OR “time-critical”)))	402
S29	((TI (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*)) OR (AB (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*)) OR (SU (telephon* OR phone* OR phoning OR “phone-call” OR	1209

	"phone-calls" OR phonecall* OR smartphon* OR cellphon*)) OR (MW (telephon* OR phone* OR phoning OR "phone-call" OR "phone-calls" OR phonecall* OR smartphon* OR cellphon*))) AND ((TI (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")) OR (AB (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")))	
S30	(MH "Computing Methodologies")	549
S31	((MH "Decision Making, Computer Assisted") OR (TI ("computer-assisted" OR computerised OR computerized OR "Computerised Decision Support")) OR (AB ("computer-assisted" OR computerised OR computerized OR "Computerised Decision Support"))) AND ((TI (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")) OR (AB (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")))	119
S32	((TI (digital OR online OR internet OR web OR wifi OR "wi-fi" OR wireless OR virtual)) OR (AB (online OR internet OR web OR wifi OR "wi-fi" OR wireless OR virtual))) AND ((TI (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")) OR (AB (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")))	2,065
S33	((MH "Mobile applications") OR (MH "Social Media") OR (MH "Email") OR (MH "Voice Mail") OR (MH "Wireless Communications") OR (MH "Videoconferencing") OR (MH "Text messaging") OR (MH "Software")) AND ((TI (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")) OR (AB (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")))	854
S34	((TI ("text message" OR "text messages" OR "text-messages" OR "text messaging" OR "text-messaging" OR texting OR SMS OR "instant message" OR "instant messages" OR "instant messaging")) OR (AB ("text message" OR "text messages" OR "text-messages" OR "text messaging" OR "text-messaging" OR texting OR SMS OR "instant message" OR "instant messages" OR "instant messaging"))) AND ((TI (remote* OR distant OR distance OR "off-site" OR "off-	966

	campus" OR prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")) OR (AB (remote* OR distant OR distance OR "off-site" OR "off-campus" OR prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")))	
S35	(TI (software OR app OR apps OR email OR "e-mail" OR "electronic mail" OR multimedia)) OR (AB (software OR app OR apps OR email OR "e-mail" OR "electronic mail" OR multimedia OR digital)) AND ((TI ("patient referral" OR "referral threshold" OR "patient screening" OR "ED screening" OR "emergency screening" OR "patient prioritisation" OR "prioritisation of patients" OR "patient prioritization" OR "prioritization of patients" OR "ED streaming" OR "priority system" OR "priority systems" OR "patient stratification")) OR (AB ("patient referral" OR "referral threshold" OR "patient screening" OR "ED screening" OR "emergency screening" OR "patient prioritisation" OR "prioritisation of patients" OR "patient prioritization" OR "prioritization of patients" OR "ED streaming" OR "priority system" OR "priority systems" OR "patient stratification")))	15224
S36	(TI ("e-health" OR ehealth OR "m-health" OR mhealth OR "mobile health")) OR (AB ("e-health" OR ehealth OR "m-health" OR mhealth OR "mobile health")) OR (SU ("e-health" OR ehealth OR "m-health" OR mhealth OR "mobile health")) OR (MW ("e-health" OR ehealth OR "m-health" OR mhealth OR "mobile health")) AND ((TI (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")) OR (AB (remote* OR distant OR Distance OR "off-campus" OR "off-site" OR offsite" OR prehospital* OR "pre-hospital" OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "pre-ED" OR "pre-emergency" OR "time-critical")))	10779
S37	S20 OR S21 OR S22 OR S23 OR S24 OR S25 OR S26 OR S27 OR S28 OR S29 OR S30 OR S31 OR S32 OR S33 OR S34 OR S35 OR S36	53652
S38	S19 AND S37	2149
S39	S19 AND S37 Limiters - Published Date: 19970101-20231231	2115

EBSCO SocINDEX with Full Text

Database/resource: SocINDEX
Platform EBSCO
Search date 09 Jun 2023

Search lines	Search terms	Results
S1	(TI (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige")) OR (AB (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige")) OR (SU (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige"))	510
S2	(TX (Teletriag* OR "Tele-triage" OR "phone-triage" OR "e-triage"))	3
S3	(TX (telerefer* OR "tele-referral" OR "tele-emergency" OR "tele-emergencies" OR "e-referral"))	2

S4	(TX (“tele-consultation” OR “tele-consulted” OR “tele-consulting” OR teleconsult*))	14
S5	(TX (Undertriag* OR overtriag* OR “under-triage” OR “under-triaged” OR “over-triage” OR “over-triaged” OR mistriag* OR “mis-triage” OR “mis-triaged”))	1
S6	((TI (“patient evaluation” OR “patient assessment” OR “patient screening”)) OR (AB (“patient evaluation” OR “patient assessment” OR “patient screening”))) AND ((TI (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”)) OR (MW (prehospital* OR “pre-hospital” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “pre-ED” OR “pre-emergency” OR “time-critical”)) OR (SU (prehospital* OR “pre-hospital” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “pre-ED” OR “pre-emergency” OR “time-critical”)))	2
S7	((TI (“patient evaluation” OR “patient assessment” OR “patient screening”)) OR (AB (“patient evaluation” OR “patient assessment” OR “patient screening”))) AND ((TI remote OR distant OR distance) OR (AB remote OR distance OR distant))	0
S8	((TI (prescreen* OR “pre-screening” OR “pre-assessment” OR preassess* OR “pre-evaluation”)) OR (AB (prescreen* OR “pre-screening” OR “pre-assessment” OR preassess* OR “pre-evaluation” OR “pre-evaluated”)) OR (SU (prescreen* OR “pre-screening” OR “pre-assessment” OR preassess* OR “pre-evaluation” OR “pre-evaluated”))) AND ((TI (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”) OR (AB (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”)))	14
S9	((TI (prescreen* OR “pre-screening” OR “pre-assessment” OR preassess* OR “pre-evaluation”)) OR (AB (prescreen* OR “pre-screening” OR “pre-assessment” OR preassess* OR “pre-evaluation” OR “pre-evaluated”)) OR (SU (prescreen* OR “pre-screening” OR “pre-assessment” OR preassess* OR “pre-evaluation” OR “pre-evaluated”))) AND ((TI (GP OR “general practice” OR “general practitioner” OR “general practitioners” OR “primary care” OR doctor* OR nurse* OR “nursing” OR midwif* OR midwives OR clinician* OR responder* OR dispatch*)) OR (AB (GP OR “general practice” OR “general practitioner” OR “general practitioners” OR “primary care” OR doctor* OR nurse* OR “nursing” OR midwif* OR midwives OR clinician* OR responder* OR clinician* OR dispatch*)))	14
S10	(TI ((prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “emergency care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”) N2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter* OR consult*))) OR (AB ((prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “emergency care” OR “out-of-hours” OR “out of hours”	10

	OR “after-hours” OR “after hours” OR “time-critical”) N2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter*)))	
S11	((TI (“patient referral” OR “referral threshold” OR “patient screening” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”)) OR (AB (“patient referral” OR “referral threshold” OR “patient screening” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”)) OR (SU (“referral threshold” OR “ED screening” OR “patient screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”))) AND ((TI (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”)) OR (SU (prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)))	26
S12	((TI (“Decision support system” OR “decision support systems” OR “symptom checker” OR “symptom checkers”)) OR (AB (“Decision support system” OR “decision support systems” OR “symptom checker” OR “symptom checkers”))))	300
S13	(TX (triaje OR triaj OR triyaj OR “trijaža” OR “triaaž” OR “triažas” OR “triaža“ OR triase OR “διαλογή” OR bambanta OR “osztályozás” OR “þrígang” OR smistamento OR “šķirošana” OR whakawai OR prioritering OR “ocena stanu zdrowia rannych” OR “сортировка” OR “சோதனை” OR “ट्राइएज” (“분류” “OR “分流” OR “การทดสอบ” OR “ತ್ರಿಯಜ” OR “トリアージ”))	8
S14	S1 OR S2 OR S3 OR S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13	891
S15	(TI ((Remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*))) OR (AB ((remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*))) OR (MW ((remote OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*))) OR (SU ((remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*)))	205
S16	DE “TELECOMMUNICATION” OR DE “COMPUTER networks” OR DE “DIGITAL communications” OR DE “RURAL telecommunication” OR DE “TELECOMMUNICATION systems” OR DE “TELEGRAPH & telegraphy” OR DE “TELEPHONES” OR DE “VIRTUAL communications”	4,184
S17	((TI (Telecommunicat* OR “tele-communication” OR telecom OR telehealth OR Telemedicin* OR Telenurs* OR Telerehabil* OR “tele-health” OR “tele-medicine” OR “tele-nursing” OR “tele-rehabilitation”)) OR (AB (Telecommunicat* OR “tele-communication” OR telecom OR telehealth OR	3,018

	Telemedicin* OR Telenurs* OR Telerehabil* OR “tele-health” OR “tele-medicine” OR “tele-nursing” OR “tele-rehabilitation”)))	
S18	(TI (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”)) OR (AB (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”)) OR (SU (helpline* OR “help line” OR “help lines” OR “help-line” OR “help-lines” OR hotline* OR “hot-line” OR “hot-lines” OR “call line” OR “call lines” OR “call-line” OR “call-lines”))	1,595
S19	(TI (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”)) OR (AB (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”)) OR (SU (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”))	558
S20	((TI (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*)) OR (AB (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*)) OR (SU (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*)) OR (MW (telephon* OR phone* OR phoning OR “phone-call” OR “phone-calls” OR phonecall* OR smartphon* OR cellphon*)))	18,567
S21	((TI (“computer-assisted” OR computerised OR computerized OR “Computerised Decision Support”)) OR (AB (“computer-assisted” OR computerised OR computerized OR “Computerised Decision Support”)))	4,710
S22	((TI (digital OR online OR internet OR web OR wifi OR “wi-fi” OR wireless OR virtual)) OR (AB (online OR internet OR web OR wifi OR “wi-fi” OR wireless OR virtual)))	54,589
S23	(TI (“text message” OR “text messages” OR “text-messages” OR “text messaging” OR “text-messaging” OR texting OR SMS OR “instant message” OR “instant messages” OR “instant messaging”))	188
S24	(TI (software OR app OR apps OR email OR “e-mail” OR “electronic mail” OR multimedia)) OR (AB (software OR app OR apps OR email OR “e-mail” OR “electronic mail” OR multimedia OR digital)) AND ((TI (“patient referral” OR “referral threshold” OR “patient screening” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”)) OR (AB (“patient referral” OR “referral threshold” OR “patient screening” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”)))	2,090
S25	(TI (“e-health” OR ehealth OR “m-health“ OR mhealth OR “mobile health”)) OR (AB (“e-health” OR ehealth OR “m-health“ OR mhealth OR “mobile health”)) OR (SU (“e-health” OR ehealth OR “m-health“ OR mhealth OR “mobile health”)) OR (MW (“e-health” OR ehealth OR “m-health“ OR mhealth OR “mobile health”)) AND ((TI (remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-	312

	emergency" OR hospital* OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")))	
S26	S15 OR S16 OR S17 OR S18 OR S19 OR S20 OR S21 OR S22 OR S23 OR S24 OR S25	82,044
S27	S14 AND S26	142
S28	S14 AND S26 Limiters - Date of Publication: 19970101-20231231	115

Embase.com

Database/resource: Embase

Platform: Embase.com/Elsevier

Search date 11 Jun 2023

Search line	Search terms	Search results
#1	'patient triage'/exp OR 'patient triage'	4,260
#2	triage:ti,ab,kw OR triaged:ti,ab,kw OR triaging:ti,ab,kw OR 'self-triage':ti,ab,kw OR triageur*:ti,ab,kw OR triagist*:ti,ab,kw OR 'traige':ti,ab,kw	43,761
#3	undertriag*:ti,ab,kw OR overtriag*:ti,ab,kw OR 'under-triage':ti,ab,kw OR 'under-triaged':ti,ab,kw OR 'over-triage':ti,ab,kw OR 'over-triaged':ti,ab,kw OR mistriag*:ti,ab,kw OR 'mis-triage':ti,ab,kw OR 'mis-triaged':ti,ab,kw OR teletriag*:ti,ab,kw OR 'tele-triage':ti,ab,kw OR 'phone-triage':ti,ab,kw OR 'e-triage':ti,ab,kw OR 'e-referral':ti,ab,kw OR telerefer*:ti,ab,kw OR 'tele-referral':ti,ab,kw OR 'tele-emergency':ti,ab,kw OR 'tele-emergencies':ti,ab,kw	1,724
#4	('out-of-hours care'/exp OR 'out-of-hours care' OR 'answering service'/exp OR 'answering service') AND (screening:ti,ab OR assess*:ti,ab OR stratif*:ti,ab OR priorit*:ti,ab OR referral:ti,ab OR filter*:ti,ab OR evaluat*:ti,ab OR categoris*:ti,ab OR categoriz*:ti,ab OR decision*:ti,ab)	437
#5	'decision support system'/mj OR 'decision support system':ti,ab,kw OR 'decision support systems':ti,ab,kw OR 'symptom checker':ti,ab,kw OR 'symptom checkers':ti,ab,kw OR 'tele-consultation':ti,ab,kw OR 'tele-consulted':ti,ab,kw OR 'tele-consulting':ti,ab,kw OR teleconsult*:ti,ab,kw	23,004
#6	#4 OR #5	23,429
#7	remote:ti,ab OR distant:ti,ab OR distance:ti,ab OR prehospital*:ti,ab OR 'pre-hospital':ti,ab OR 'pre-ed':ti,ab OR 'pre-a&e':ti,ab OR 'pre-emergency':ti,ab OR 'emergency care':ti,ab OR 'urgent care':ti,ab OR 'unscheduled care':ti,ab OR 'out-of-hours':ti,ab OR 'out of hours':ti,ab,kw OR 'out-of-hospital':ti,ab OR 'out of hospital':ti,ab OR 'ooh-pc':ti,ab OR 'after-hours':ti,ab OR 'after hours':ti,ab OR 'time-critical':ti,ab	674,288
#8	#6 AND #7	1,983
#9	((prehospital* OR 'pre-hospital' OR 'pre-ed' OR 'pre-emergency' OR 'urgent care' OR 'unscheduled care' OR 'emergency care' OR 'out-of-hours' OR 'out of hours' OR 'out-of-hospital' OR 'out of hospital' OR 'after-hours' OR 'after hours' OR 'time-critical') NEAR/2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter* OR consult*)):ti,ab,kw	632
#10	('preliminary assessment':ti,ab,kw OR 'preliminary screening':ti,ab,kw) AND (gp:ti,ab,kw OR 'general practice':ti,ab,kw OR 'general practitioner':ti,ab,kw OR 'general practitioners':ti,ab,kw OR 'primary care':ti,ab,kw OR doctor*:ti,ab,kw OR nurse*:ti,ab,kw OR 'nursing':ti,ab,kw OR midwif*:ti,ab,kw OR midwives:ti,ab,kw OR clinician*:ti,ab,kw OR responder*:ti,ab,kw OR dispatch*:ti,ab,kw)	340

#11	‘emergency medical dispatch’/exp AND (patient AND ‘referral’/exp OR refer*:ti,ab,kw OR screen*:ti,ab,kw OR priorit*:ti,ab,kw)	72
#12	triaje:ti,ab,kw OR triaj:ti,ab,kw OR triyaj:ti,ab,kw OR ‘trijaža’:ti,ab,kw OR ‘triaaž’:ti,ab,kw OR ‘triažas’:ti,ab,kw OR ‘triaža’:ti,ab,kw OR triase:ti,ab,kw OR ‘διαλογή’:ti,ab,kw OR bambanta:ti,ab,kw OR ‘osztályozás’:ti,ab,kw OR ‘þrígang’:ti,ab,kw OR smistamento:ti,ab,kw OR ‘šķirošana’:ti,ab,kw OR whakawai:ti,ab,kw OR prioritering:ti,ab,kw OR ‘ocena stanu zdrowia rannych’:ti,ab,kw OR ‘сортировка’:ti,ab,kw OR ‘சோதனை’:ti,ab,kw OR ‘ट्राइएज’:ti,ab,kw OR ‘분류’:ti,ab,kw OR ‘分流’:ti,ab,kw OR ‘การทดสอบ’:ti,ab,kw OR ‘త్రిఅజ్ఞ’:ti,ab,kw OR ‘トリアージ’:ti,ab,kw	476
#13	#1 OR #2 OR #3 OR #8 OR #9 OR #10 OR #11 OR #12	47,752
#14	‘teleconsultation’/mj OR ‘teleconsultation’:ti,ab,kw OR ‘telemedicine’/mj OR ‘telehealth’:ti,ab	39,052
#15	‘voice mail’/mj OR ‘social media’/mj OR ‘e-mail’/mj OR ‘text messaging’/mj OR ‘mobile application’/mj OR ‘wireless communication’/mj OR ‘telephone’/mj OR ‘software’/mj	89,735
#16	((‘computer-assisted’ OR ‘computerised decision support’ OR software OR app OR apps OR email OR ‘e-mail’ OR ‘electronic mail’ OR internet OR wifi OR ‘wi-fi’ OR wireless OR ‘virtual triage’ OR virtual) NEAR/5 (triage OR referral)):ti,ab	614
#17	((‘e-health’ OR ehealth OR ‘m-health’ OR mhealth OR ‘mobile health’) NEAR/5 (triage* OR referral)):ti,ab	31
#18	‘text message’:ti,ab,kw OR ‘text messages’:ti,ab,kw OR ‘text-messages’:ti,ab,kw OR ‘text messaging’:ti,ab,kw OR ‘text-messaging’:ti,ab,kw OR texting:ti,ab,kw OR sms:ti,ab,kw OR ‘instant message’:ti,ab,kw OR ‘instant messages’:ti,ab,kw OR ‘instant messaging’:ti,ab,kw	18,740
#19	telephon*:ti,ab,kw OR phone*:ti,ab,kw OR phoning:ti,ab,kw OR ‘phone-call’:ti,ab,kw OR ‘phone-calls’:ti,ab,kw OR phonecall*:ti,ab,kw OR smartphon*:ti,ab,kw OR cellphon*:ti,ab,kw	199,844
#20	telemedicin* OR telenurs* OR telerehabil* OR ‘tele-medicine’ OR ‘tele-nursing’ OR ‘tele-rehabilitation’:ti,ab,kw	61,797
#21	#14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20	347,169
#22	remote* OR distant OR distance OR ‘off-site’ OR ‘off-campus’ OR prehospital* OR ‘pre-hospital’ OR ‘pre-ed’ OR ‘pre-a&e’ OR ‘pre-emergency’ OR emergenc* OR ‘urgent care’ OR ‘unscheduled care’ OR ‘out-of-hours’ OR ‘out of hours’ OR ‘ooh-pc’ OR ‘after-hours’ OR ‘after hours’ OR ‘time-critical’:ti,ab,kw	1,722,713
#23	#21 AND #22	54,975
#24	‘telediagnosis’/exp	531
#25	‘call center’/mj OR ‘hotline’/mj	349
#26	helpline*:ti,ab,kw OR ‘help line’:ti,ab,kw OR ‘help lines’:ti,ab,kw OR ‘help-line’:ti,ab,kw OR ‘help-lines’:ti,ab,kw OR hotline*:ti,ab,kw OR ‘hot-line’:ti,ab,kw OR ‘hot-lines’:ti,ab,kw OR ‘call line’:ti,ab,kw OR ‘call lines’:ti,ab,kw OR ‘call-line’:ti,ab,kw OR ‘call-lines’:ti,ab,kw	4,366
#27	‘call centre’:ti,ab,kw OR ‘call centres’:ti,ab,kw OR ‘call center’:ti,ab,kw OR ‘call centers’:ti,ab,kw OR callcentre*:ti,ab,kw OR callcenter*:ti,ab,kw OR ‘call-centre’:ti,ab,kw OR ‘call-centres’:ti,ab,kw OR ‘call-center’:ti,ab,kw OR ‘call-centers’:ti,ab,kw	1,753
#28	#23 OR #24 OR #25 OR #26 OR #27	60,527
#29	#13 AND #28	5,090
#30	#13 AND #28 AND [1997-2023]/py	4,993

International HTA database (INAHTA)

Database/resource: International HTA database (INAHTA)

Platform: https://database.inahta.org/ https://database.inahta.org/search/advanced

Search date: 10 Jun 2023

Search line	Search terms	Search results
1	((“Triage”[mh]) OR (Triage* OR triaging OR “self-triage” OR triageur* OR triagist* OR “traige” OR Teletriag* OR “Tele-triage” OR “phone-triage” OR “e-triage” Undertriag* OR overtriag* OR “under-triage” OR “under-triaged” OR “over-triage” OR “over-triaged” OR mistriag* OR “mis-triage” OR “mis-triaged” OR telerefer* OR “tele-referral” OR “tele-emergency” OR “tele-emergencies” OR “e-referral” OR “tele-consultation” OR “tele-consulted” OR “tele-consulting” OR teleconsult*)) AND ((remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) FROM 1997 TO 2023	214
2	((“Referral and Consultation”[mh] OR “After-Hours Care”[mh] OR “Answering Services”[mh]) AND ((remote* OR distant OR distance OR “off-site” OR “off-campus” OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR hospital* OR emergenc* OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) FROM 1997 TO 2023	32
3	((“Decision support system” OR “decision support systems” OR “symptom checker” OR “symptom checkers”))[abs] AND ((Remote* OR distance OR distant OR “off-site” OR “off-campus”))[abs] FROM 1997 TO 2023	65
	Total	

Lenus

Database/resource: Lenus, the Irish Health Repository

Platform https://www.lenus.ie/

Search date 10 Jun 2023

Search line	Search terms	Search results
1	Triage. Subject: remote OR distant OR distance	2
2	(triage OR triaged OR triaging OR undertriage OR overtriage OR mistriage) Subject: triage	11
3	Subject: triage	11
4	Telereferral	1
5	Teletriage	6
6	“Symptom checker” Subject: triage	0
7	“Preliminary assessment” Subject: triage	0
	Total	31

LILACS -VHL

Database/resource: LILACS – VHL portal

Platform https://search.bvsalud.org/portal/?lang=en

Search date: 10 Jun 2023
Date limit 1997-2023

Search line	Search terms	Results: all databases	Results excluding MEDLINE
1	(Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige") AND (remote OR distant OR distance) AND (prehospital OR "pre-hospital" OR "pre-ED" OR "pre-emergency" OR "urgent care" OR "unscheduled care" OR "emergency care" OR "out-of-hours" OR "out of hours" OR "out-of-hospital" OR "out of hospital" OR "after-hours" OR "after hours" OR "time-critical")	MEDLINE (45,315) LILACS (569) IBECS (400) WPRIM (Western Pacific) (213) BBO - Dentistry (26) CUMED (24) Coleciona SUS (24) BINACIS (19) Sec. Est. Saúde SP (19) WHO IRIS (18) AIM (Africa) (16) BDENF - Nursing (12) LIPECS (7) Hanseníase Leprosy (6) Multimedia Resources (6) Index Psychology - journals (5) MedCarib (4) VETINDEX (4) LIS -Health Information Locator (3) PAHO-IRIS (3) BDNPAR (2) BRISA/RedTESA (2) PAHO (2) PIE (2) medRxiv (2) RHS Repository (2) CVSP - Brazil (2) BIGG - GRADE guidelines (1) DeCS - Descriptors in Health Sciences (1) MINSAPERÚ (1) SciELO Preprints (1) SDG (1)	Resulting in 1,300
2	("preliminary assessment" OR prioritisation OR prioritization) AND (remote OR distance OR distant) AND ((prehospital OR "pre-hospital" OR "pre-ED" OR "pre-emergency" OR "urgent care" OR "unscheduled care" OR	MEDLINE (737) LILACS (12) IBECS (8) medRxiv (5) Multimedia Resources (4) WPRIM (Western Pacific) (4)	Exported 38

	“emergency care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”))	BDENF - Nursing (2) PAHO-IRIS (2) AIM (Africa) (1) BINACIS (1) CUMED (1) PAHO (1) RHS Repository (1) WHO IRIS (1)	
Total			1,338

medRxiv/bioRxiv

Database/resource medrxiv/biorxiv

Platform https://www.medrxiv.org/search (Searching medrxiv AND biorxiv)

Search date 11 Jun 2023

Search number	Search terms	Search results
1	remote triage Title and abstract	9 Results for abstract or title “remote triage” (match all words)
2	prehospital triage	7 Results for abstract or title “prehospital triage” (match all words)
3	“pre-hospital triage”	9 Results for abstract or title “pre-hospital triage” (match all words)
4	“pre-emergency triage”	No Results for abstract or title “pre-emergency triage” (match all words)
5	“telephone triage”	12 Results for abstract or title “telephone triage” (match all words)
6	“phone triage”	No Results for title “phone triage” (match all words) 14 Results for title “phone triage” (match all words) and abstract or title “phone triage” (match all words)
	“online triage”	34 Results for abstract or title “online triage” (match all words)
8	“out-of-hours triage”	1 Results for abstract or title “out-of-hours triage” (match all words)
9	“emergency triage distance	1 Results for abstract or title “emergency triage distance” (match all words)
10	“urgent care triage”	14 Results for abstract or title “urgent care triage” (match all words)
11	“teletriage”	No Results

		for abstract or title “teletriage” (match all words)
12	“tele-triage”	No Results for abstract or title “tele-triage” (match all words)
13	“tele-consultation”	1 Result for abstract or title “tele-consultation” (match all words)
14	remote consultation	18 Results for abstract or title “remote consultation” (match all words)
	Total	120

OPENGrey via DANS

Database/resource: OPENGrey

Platform: https://opengrey.eu/ OpenGREY via DANS https://easy.dans.knaw.nl/ui/datasets/id/easy-dataset:200362/tab/2

Search date: 11 Jun 2023

Search number	Search terms	Search results
1	Title: Remote triage	0
2	Any field: remote triage	1
3	Any field: triage	24
4	Any field: telereferral	0
5	Any field: Teletriage	0
6	Any field: teleconsultation	6
	Total	31

Osf.io

Database/resource: OSF.io

Platform: https://osf.io https://osf.io/preprints/

Search date: 11 Jun 2023

Search number	Search terms	Search results
1	‘remote triage’	0
2	“prehospital triage”	1
3	“pre-hospital triage”	2
4	“pre-emergency triage”	0
5	“telephone triage”	0
6	“phone triage”	0
7	“online triage”	0
8	“out-of-hours triage”	0

9	“emergency triage”	9 results of which 4 projects – 4 exported (other 5 = zip files from those projects)
10	“urgent care triage”	0
11	“teletriage”	0
12	“tele-triage”	0
13	“tele-consultation”	0
14	“remote consultation”	16
	Total	23

Ovid PsycINFO

Database/resource: APA PsycINFO 1806 to May Week 5 2023
Platform Ovid
Search date 09 Jun 2023

1	(Triage* or triaging or “self-triage” or triageur* or triagist* or “traige”).mp.	2,448
2	(Teletriag* or “Tele-triage” or “phone-triage” or “e-triage”).mp.	11
3	(telerefer* or “tele-referral” or “tele-emergency” or “tele-emergencies” or “e-referral”).mp.	25
4	(“tele-consultation” or “tele-consulted” or “tele-consulting” or teleconsult*).mp.	312
5	(Undertriag* or overtriag* or “under-triage” or “under-triaged” or “over-triage” or “over-triaged” or mistriag* or “mis-triage” or “mis-triaged”).mp.	25
6	((“patient evaluation” or “patient assessment” or “patient screening”) and (prehospital* or “pre-hospital” or “pre-ED” or “pre-emergency” or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “out-of-hospital” or “out of hospital” or “after-hours” or “after hours” or “time-critical”)).mp.	5
7	((“patient evaluation” or “patient assessment” or “patient screening”) and (remote or distant or distance)).mp.	22
8	(exp professional referral/ or health screening/ or exp self-referral/) and (prehospital* or “pre-hospital” or “pre-ED” or “pre-emergency” or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “out-of-hospital” or “out of hospital” or “after-hours” or “after hours” or “time-critical”).mp.	20
9	((prescreen* or “pre-screening” or “pre-assessment” or preassess* or “pre-evaluation”) and (prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “out-of-hospital” or “out of hospital” or “after-hours” or “after hours” or “time-critical”)).mp.	89
10	((prescreen* or “pre-screening” or “pre-assessment” or preassess* or “pre-evaluation”) and (GP or “general practice” or “general practitioner” or “general practitioners” or “primary care” or doctor* or nurse* or “nursing” or midwif* or midwives or clinician* or responder* or dispatch*)).mp.	124

11	((prehospital* or “pre-hospital” or “pre-ED” or “pre-emergency” or “urgent care” or “unscheduled care” or “emergency care” or “out-of-hours” or “out of hours” or “out-of-hospital” or “out of hospital” or “after-hours” or “after hours” or “time-critical”) adj2 (screen* or stratif* or prioritise* or prioritize* or referral or refer or filter* or consult*)).mp.	35
12	((“patient referral” or “referral threshold” or “patient screening” or “ED screening” or “emergency screening” or “patient prioritisation” or “prioritisation of patients” or “patient prioritization” or “prioritization of patients” or “ED streaming” or “priority system” or “priority systems” or “patient stratification”) and (remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”)).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word]	123
13	(Decision Support Systems/ or (“Decision support system” or “decision support systems” or “symptom checker” or “symptom checkers”).mp.) and (prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or “urgent care” or “unscheduled care” or “emergency care” or “out-of-hours” or “out of hours” or “OOH-PC” or “out-of-hospital” or “out of hospital” or “after-hours” or “after hours” or “time-critical”).mp.	17
14	((“Decision support system” or “decision support systems” or “symptom checker” or “symptom checkers”).mp. or Decision Support Systems/) and (prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or “urgent care” or “unscheduled care” or “emergency care” or “out-of-hours” or “out of hours” or “OOH-PC” or “out-of-hospital” or “out of hospital” or “after-hours” or “after hours” or “time-critical”).mp.	17
15	(triaje or triaj or triyaj or “trijaža” or “triaaž” or “triažas” or “triaža” or triase or “διαλογή” or bambanta or “osztályozás” or “þrígang” or smistamento or “šķirošana” or whakawai or prioritering or “ocena stanu zdrowia rannych” or “сортировка” or “சோதனை” or “ट्राइएज” or “분류” or “分流” or “การทดสอบ” or “ტრიაჟი” or “トリアージ”).mp.	6
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	3,154
17	((Remote* or distance or distant or “off-site” or “off-campus”) adj2 (consult* or refer* or assess* or screen*)).mp.	1,652
18	(remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”).mp. and telemedicine/	2,829
19	Teleconsultation/	136
20	(Telecommunications media/ or radio/ or telephone systems/ or television/ or wireless technologies/ or internet/) and (remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”).mp.	4,214

21	(Telecommunicat* or “tele-communication” or telecom or telehealth or Telemedicin* or Telenurs* or Telerehabil* or “tele-health” or “tele-medicine” or “tele-nursing” or “tele-rehabilitation”).mp.	14,494
22	exp hot line services/	1,192
23	(helpline* or “help line” or “help lines” or “help-line” or “help-lines” or hotline* or “hot-line” or “hot-lines” or “call line” or “call lines” or “call-line” or “call-lines”).mp.	2,510
24	(“call centre” or “call centres” or “call center” or “call centers” or callcentre* or callcenter* or “call-centre” or “call-centres” or “call-center” or “call-centers”).mp.	946
25	((remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”) and (telephon* or phone* or phoning or “phone-call” or “phone-calls” or phonecall* or smartphon* or cellphon*)).mp.	8,511
26	(remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”).mp. and (computer software/ or computer applications/ or computers/)	1,740
27	((“computer-assisted” or computerised or computerized or “Computerised Decision Support”) and (remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”)).mp.	6,061
28	((digital or online or internet or web or wifi or “wi-fi” or wireless or virtual) and (remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”)).mp.	26,495
29	(remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”).mp. and (social media/ or computer mediated communication/ or websites/)	2,238
30	((“text message” or “text messages” or “text-messages” or “text messaging” or “text-messaging” or texting or SMS or “instant message” or “instant messages” or “instant messaging”) and (remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or “unscheduled care” or “out-of-hours” or “out of hours” or “OOH-PC” or “after-hours” or “after hours” or “time-critical”)).mp.	665
31	((software or app or apps or email or “e-mail” or “electronic mail” or multimedia) and (remote* or distant or distance or “off-site” or “off-campus” or prehospital* or “pre-hospital” or “pre-ED” or “pre-A&E” or “pre-emergency” or hospital* or emergenc* or “urgent care” or	5,692

	"unscheduled care" or "out-of-hours" or "out of hours" or "OOH-PC" or "after-hours" or "after hours" or "time-critical")).mp.	
32	(("e-health" or ehealth or "m-health" or mhealth or "mobile health") and (remote* or distant or distance or "off-site" or "off-campus" or prehospital* or "pre-hospital" or "pre-ED" or "pre-A&E" or "pre-emergency" or hospital* or emergenc* or "urgent care" or "unscheduled care" or "out-of-hours" or "out of hours" or "OOH-PC" or "after-hours" or "after hours" or "time-critical")).mp.	989
33	or/17-32	56,627
34	16 and 33	713
35	limit 34 to yr="1997 - 2023"	703

Research Square

Database/resource: Research Square

Platform: https://www.researchsquare.com/

Search date: 11 Jun 2023

Explanatory note: No export option for results, poor search facility, no refined search. Manual export of each result. This limited the extent of the search.

Search number	Search terms	Search results
1	Title: remote triage. Subject: Critical care and emergency medicine	35
2	Title: prehospital triage. Subject: general practice	1
3	Prehospital triage. Subject: Critical care and emergency med	63
	Total	99

Search strategies: Supplemental searches

(Note: While some of the resources listed here as used at the supplemental search stage would traditionally be considered supplemental methods (for example, search engines), others used were standard search databases (for example, SciELO or the updated MEDLINE search described), and were included for usefulness at this stage rather than for use as 'supplemental' methods.

Clinicaltrials.gov

Database/resource: Clinicaltrials .gov

Platform: https://clinicaltrials.gov/

Search date: 13 Oct 2023

Search number	Search terms	Results
1	Intervention/treatment: emergency remote triage	2 (All trials)
2	Intervention/treatment: pre-emergency triage	25
3	Intervention/treatment out-of-hours triage	9
4	Intervention/treatment: emergency teletriage	0
5	Intervention/treatment: prehospital triage urgent	0
6	Intervention/treatment: prehospital triage	17
7	Intervention/treatment: urgent care triage	14
	total	67

DuckDuckgo.com

Database/resource: DuckDuckGo

Platform: https://duckduckgo.com/

Search date: 13 Oct 2023
Filters; Safe search: Moderate. Time: any time; Ireland filter : Off.

Search line	Search terms	
1	intitle:emergency remote triage	87
2	intitle:"pre-emergency" "triage"	12
3	intitle:out-of-hours triage trial	11
4	intitle:out-of-hours triage cohort	15
5	intitle:emergency teletriage	15
6	intitle:prehospital triage urgent 1st 100	100
7	intitle:prehospital triage emergency 1st 100	100
	total	340

Google Scholar

Database/resource: Google Scholar
Platform: Google https://scholar.google.com/
Search date: 13 Oct 2023
Browser: Google Chrome Version 118.0.5993.71 (Official Build) (64-bit)

Search number	Search terms	Google-stated results	Extractable results
1	allintitle: emergency remote triage	About 26 results (0.08 sec)	17
2	allintitle: pre-emergency triage	0	0
3	allintitle: out-of-hours triage	About 84 results (0.03 sec)	71
4	allintitle: emergency teletriage	5 results (0.04 sec)	5
5	allintitle: prehospital triage urgent	8 results (0.04 sec)	8
6	allintitle: prehospital triage emergency	About 66 results (0.05 sec)	59
	Total		159

EBSCO MEDLINE

Database/resource: MEDLINE
Platform: EBSCO
Search: 16 Oct 2023

Search line	Search terms	Limiters/Expanders	Results
S1	(MH "Triage") OR (TI (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige")) OR (AB (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige")) OR (SU (Triage* OR triaging OR "self-triage" OR triageur* OR triagist* OR "traige"))	Expanders - Apply equivalent subjects	33,631
S2	(TI (Undertriag* OR overtriag* OR "under-triage" OR "under-triaged" OR "over-triage" OR "over-triaged" OR mistriag* OR "mis-triage" OR "mis-triaged" OR Teletriag* OR "Tele-triage" OR "phone-triage" OR "e-triage" OR "e-referral" OR telerefer* OR "tele-referral" OR "tele-emergency" OR "tele-emergencies")) OR (AB (Undertriag* OR overtriag* OR "under-triage" OR "under-triaged" OR "over-triage" OR "over-triaged" OR mistriag* OR "mis-triage" OR "mis-triaged" OR Teletriag* OR "Tele-triage" OR "phone-triage" OR "e-triage" OR "e-referral" OR telerefer* OR "tele-referral" OR "tele-emergency" OR "tele-emergencies")) OR (SU (Undertriag* OR overtriag* OR "under-triage" OR "under-triaged" OR "over-triage" OR "over-triaged" OR mistriag* OR "mis-triage" OR "mis-triaged" OR Teletriag* OR "Tele-triage" OR "phone-triage" OR "e-triage" OR "e-referral" OR telerefer* OR "tele-referral" OR "tele-emergency" OR "tele-emergencies"))	Expanders - Apply equivalent subjects	1,192
S3	((MH "After-Hours Care+") OR (MH "Answering Services")) AND ((TI (screening OR assess* OR stratif* OR priorit* OR referral OR filter* OR evaluat* OR categoris* OR categoriz* OR decision*)) OR (AB (screening OR stratif* OR prioritis* OR prioritiz* OR referral OR filter* OR evaluat* OR categoris* OR categoriz* OR decision*)))	Expanders - Apply equivalent subjects	639

S4	((TI (prescreen* OR “pre-screening” OR “pre-assessment” OR preassess* OR “pre-evaluation” OR “patient referral” OR “referral threshold” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”)) OR (AB (prescreen* OR “pre-screening” OR “pre-assessment” OR preassess* OR “pre-evaluation” OR “patient referral” OR “referral threshold” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”)))	Expanders - Apply equivalent subjects	10,231
S5	(MH “Referral and Consultation”) AND ((TI (Assess* OR evaluat* OR screen* OR priorit*)) OR (AB (Assess* OR evaluat* OR screen* OR priorit*)))	Expanders - Apply equivalent subjects	27,921
S6	((MH “Decision Support Systems, Clinical”) OR ((TI (“Decision support system” OR “decision support systems” OR “symptom checker” OR “symptom checkers”)) OR (AB (“Decision support system” OR “decision support systems” OR “symptom checker” OR “symptom checkers”))))	Expanders - Apply equivalent subjects	14,497
S7	S4 OR S5 OR S6	Expanders - Apply equivalent subjects	52,186
S8	((TI (remote OR distant OR distance OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR “emergency care” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) OR (AB (remote OR distance OR distant prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR “emergency care” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)) OR (SU (remote OR distant OR distance OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR “emergency care” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical”)))	Expanders - Apply equivalent subjects	512,078
S9	S7 AND S8	Expanders - Apply equivalent subjects	2,026
S10	(TI ((prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “emergency care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “after-hours” OR “after hours” OR “time-critical”) N2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter* OR consult*))) OR (AB ((prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-emergency” OR “urgent care” OR “unscheduled care” OR “emergency care” OR “out-of-hours” OR “out of hours” OR “after-hours” OR “after	Expanders - Apply equivalent subjects	415

	hours” OR “time-critical”) N2 (screen* OR stratif* OR prioritise* OR prioritize* OR referral OR refer OR filter*)))		
S11	TI (“tele-consultation” OR “tele-consulted” OR “tele-consulting” OR teleconsult*) OR AB (“tele-consultation” OR “tele-consulted” OR “tele-consulting” OR teleconsult*) OR SU (“tele-consultation” OR “tele-consulted” OR “tele-consulting” OR teleconsult*)	Expanders - Apply equivalent subjects	2,430
S12	((TI (“preliminary assessment” OR “preliminary screening”)) OR (AB (“preliminary assessment” OR “preliminary screening”)) OR (SU (“preliminary assessment” OR “preliminary screening”))) AND ((TI (GP OR “general practice” OR “general practitioner” OR “general practitioners” OR “primary care” OR doctor* OR nurse* OR “nursing” OR midwif* OR midwives OR clinician* OR responder* OR dispatch*)) OR (AB (GP OR “general practice” OR “general practitioner” OR “general practitioners” OR “primary care” OR doctor* OR nurse* OR “nursing” OR midwif* OR midwives OR clinician* OR responder* OR clinician* OR dispatch*)))	Expanders - Apply equivalent subjects	199
S13	(MH “Emergency Medical Service Communication Systems”) AND ((MH “Referral and Consultation”) OR ((TI refer* OR screen* OR priorit*) OR (AB refer* OR screen* OR priorit*)))	Expanders - Apply equivalent subjects	233
S14	(TX (triaje OR triaj OR triyaj OR “trijaža” OR “triaaž” OR “triažas” OR “triaža“ OR triase OR “διαλογή” OR bambanta OR “osztályozás” OR “þrígang” OR smistamento OR “šķirošana” OR whakawai OR prioritering OR “ocena stanu zdrowia rannych” OR “сортировка” OR “சோதனை” OR “ट्राइएज” OR “분류” OR “分流” OR “การทดสอบ” OR “ტრიაჟი” OR “トリアージ”))	Expanders - Apply equivalent subjects	509
S15	S1 OR S2 OR S3 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14	Expanders - Apply equivalent subjects	39,308
S16	(MH “Remote consultation+”)	Expanders - Apply equivalent subjects	5,839
S17	((MH “Telemedicine+”) OR (MH “Telecommunications”) OR (MH “Telephone+”) OR (MH “Computing Methodologies”) OR (MH “Mobile applications”) OR (MH “Social Media”) OR (MH “Electronic Mail”))	Expanders - Apply equivalent subjects	105,653
S18	((TI (“computer-assisted” OR computerised OR computerized OR “Computerised Decision Support” OR software OR app OR apps OR email OR “e-mail” OR “electronic mail” OR multimedia OR digital OR online OR internet OR web OR wifi OR “wi-fi” OR wireless OR virtual)) OR (AB(“computer-assisted” OR computerised OR computerized OR “Computerised Decision Support” software OR app OR apps OR email OR “e-mail” OR “electronic mail” OR multimedia OR online OR internet OR web OR wifi OR “wi-fi” OR wireless OR virtual)))	Expanders - Apply equivalent subjects	774,953
S19	(TI (“e-health” OR ehealth OR “m-health” OR mhealth OR “mobile health”)) OR (AB (“e-health” OR ehealth OR “m-health” OR mhealth OR “mobile health”)) OR (SU (“e-health” OR ehealth OR “m-health“ OR mhealth OR “mobile	Expanders - Apply equivalent subjects	27,908

	health")) OR (MW ("e-health" OR ehealth OR "m-health" OR mhealth OR "mobile health"))		
S20	((TI ("text message" OR "text messages" OR "text-messages" OR "text messaging" OR "text-messaging" OR texting OR SMS OR "instant message" OR "instant messages" OR "instant messaging")) OR (AB ("text message" OR "text messages" OR "text-messages" OR "text messaging" OR "text-messaging" OR texting OR SMS OR "instant message" OR "instant messages" OR "instant messaging")))	Expanders - Apply equivalent subjects	14,298
S21	((TI (telephon* OR phone* OR phoning OR "phone-call" OR "phone-calls" OR phonecall* OR smartphon* OR cellphon*)) OR (AB (telephon* OR phone* OR phoning OR "phone-call" OR "phone-calls" OR phonecall* OR smartphon* OR cellphon*)) OR (SU (telephon* OR phone* OR phoning OR "phone-call" OR "phone-calls" OR phonecall* OR smartphon* OR cellphon*))	Expanders - Apply equivalent subjects	162,264
S22	(TI (Telecommunicat* OR "tele-communication" OR telecom OR telehealth OR Telemedicin* OR Telenurs* OR Telerehabil* OR "tele-health" OR "tele-medicine" OR "tele-nursing" OR "tele-rehabilitation")) OR (AB (Telecommunicat* OR "tele-communication" OR telecom OR telehealth OR Telemedicin* OR Telenurs* OR Telerehabil* OR "tele-health" OR "tele-medicine" OR "tele-nursing" OR "tele-rehabilitation"))	Expanders - Apply equivalent subjects	36,493
S23	S17 OR S18 OR S19 OR S20 OR S21 OR S22	Expanders - Apply equivalent subjects	972,525
S24	((TI (remote* OR distant OR distance OR "off-site" OR "off-campus" OR prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")) OR (AB (remote* OR distant OR distance OR "off-site" OR "off-campus" OR prehospital* OR "pre-hospital" OR "pre-ED" OR "pre-A&E" OR "pre-emergency" OR emergenc* OR "urgent care" OR "unscheduled care" OR "out-of-hours" OR "out of hours" OR "OOH-PC" OR "after-hours" OR "after hours" OR "time-critical")))	Expanders - Apply equivalent subjects	1,058,733
S25	S23 AND S24	Expanders - Apply equivalent subjects	77,795
S26	(TI (helpline* OR "help line" OR "help lines" OR "help-line" OR "help-lines" OR hotline* OR "hot-line" OR "hot-lines" OR "call line" OR "call lines" OR "call-line" OR "call-lines")) OR (AB (helpline* OR "help line" OR "help lines" OR "help-line" OR "help-lines" OR hotline* OR "hot-line" OR "hot-lines" OR "call line" OR "call lines" OR "call-line" OR "call-lines")) OR (SU (helpline* OR "help line" OR "help lines" OR "help-line" OR "help-lines" OR hotline* OR "hot-line" OR "hot-lines" OR "call line" OR "call lines" OR "call-line" OR "call-lines"))	Expanders - Apply equivalent subjects	4,978
S27	(TI ("call centre" OR "call centres" OR "call center" OR "call centers" OR callcentre* OR callcenter* OR "call-centre" OR "call-centres" OR "call-center" OR "call-centers")) OR (AB	Expanders - Apply equivalent subjects	1,144

	(“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”)) OR (SU (“call centre” OR “call centres” OR “call center” OR “call centers” OR callcentre* OR callcenter* OR “call-centre” OR “call-centres” OR “call-center” OR “call-centers”))		
S28	(MH “Hotlines”) OR (MH “Call Centers”)	Expanders - Apply equivalent subjects	3,081
S29	(TI ((Remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*))) OR (AB ((remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*))) OR (SU ((remote* OR distance OR distant OR “off-site” OR “off-campus”) N2 (consult* OR refer* OR assess* OR screen*)))	Expanders - Apply equivalent subjects	13,165
S30	S16 OR S25 OR S26 OR S27 OR S28 OR S29	Expanders - Apply equivalent subjects	91,762
S31	S15 AND S30	Expanders - Apply equivalent subjects	5,291
S32	S15 AND S30	Limiters - Date of Publication: 20230101-20231231	405

Epistemonikos

Database/resource: Epistemonikos

Platform: https://www.epistemonikos.org/en/advanced_search

Search date: 13 Oct 2023

Search number	Search terms	Search results
1.	(advanced_title_en:(triage OR triaged OR triaging OR triagist OR triageur OR undertriag* OR overtriag* OR “over-triage” OR “over-triaged” OR “under-triage” OR “under-triaged” OR teletriage OR “tele-triage” OR “tele-triaged” OR “tele-emergency” OR “tele-emergencies” OR “e-triage” OR “e-referral” OR “tele-referral” OR mistriage OR “mis-triage” OR “Answering Services” OR prescreen OR “pre-screening” OR “pre-assessment” OR preassess OR “pre-evaluation” OR “patient referral” OR “referral threshold” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”) OR advanced_abstract_en:(triage OR triaged OR triaging OR triagist OR triageur OR undertriag* OR overtriag* OR “over-triage” OR “over-triaged” OR “under-triage” OR “under-triaged” OR teletriage OR “tele-triage” OR “tele-triaged” OR “tele-emergency” OR “tele-emergencies” OR “e-triage” OR “e-referral” OR “tele-referral” OR mistriage OR “mis-triage” OR “Answering Services” OR prescreen OR “pre-screening” OR “pre-assessment” OR preassess OR “pre-evaluation” OR “patient referral” OR “referral threshold” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient	859

	prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”)) AND advanced_title_en:(remote OR distant OR distance OR prehospital* OR “pre-hospital” OR “pre-ED” OR “pre-A&E” OR “pre-emergency” OR “emergency care” OR “urgent care” OR “unscheduled care” OR “out-of-hours” OR “out of hours” OR “out-of-hospital” OR “out of hospital” OR “OOH-PC” OR “after-hours” OR “after hours” OR “time-critical” OR tele*) [Filters: protocol=no]	

SciELO

Database/resource: Scielo

Platform: https://search.scielo.org/
Search date: 13 Oct 2023

Search number	Search terms	Results
1	(triage OR triaged OR triaging OR triagist OR triageur OR undertriag* OR overtriag* OR “over-triage” OR “over-triaged” OR “under-triage” OR “under-triaged” OR teletriage OR “tele-triage” OR “tele-triaged” OR “tele-emergency” OR “tele-emergencies” OR “e-triage” OR “e-referral” OR “tele-referral” OR mistriage OR “mis-triage”) AND (“emergency” OR “Emergência” OR “pre-emergency” OR “ED” OR “urgent care” OR Urgencia OR “after-hours care” OR “tele-emergency” OR “tele-emergencies”)	273
2	(((“Answering Services” OR prescreen OR “pre-screening” OR “pre-assessment” OR preassess OR “pre-evaluation” OR “patient referral” OR “referral threshold” OR “ED screening” OR “emergency screening” OR “patient prioritisation” OR “prioritisation of patients” OR “patient prioritization” OR “prioritization of patients” OR “ED streaming” OR “priority system” OR “priority systems” OR “patient stratification”))) AND (“emergency” OR emergencies OR “Emergência” OR emergencia OR “département d’urgence” OR “soin d’urgence” OR “pre-emergency” OR “ED” OR “urgent care” OR “urgência” OR urgencia OR urgence OR “after-hours care” OR “cuidados após o expediente” OR “atención fuera de horario” OR “garde après les heures normales” OR “tele-emergency” OR “tele-emergencies” OR “tele-emergência” OR “teleemergencia”)	16
3	(“Decision support system” OR “decision support systems” OR “symptom checker” OR “symptom checkers” OR “priorización de pacientes” OR “priorização de pacientes” OR “Sistemas de Suporte à Decisão” OR “Sistemas de Soporte a la Decisión” OR “comprobador de síntomas” OR “verificador de sintomas” OR “pré-seleção” OR “preselección”) AND (“emergency” OR emergencies OR “Emergência” OR emergencia OR “département d’urgence” OR “soin d’urgence” OR “pre-emergency” OR “ED” OR “urgent care” OR “urgência” OR urgencia OR urgence OR “after-hours care” OR “cuidados após o expediente” OR “atención fuera de horario” OR “garde après les heures normales” OR “tele-emergency” OR “tele-emergencies” OR “tele-emergência” OR “teleemergencia”)	11

4	(triaje OR triagem OR “système de tri” OR “examen de emergencia”) AND (Telefone OR Teléfono OR Smartphone OR Internet OR Teletriagem OR teletriaje)	28
	Total	328

Appendix C Excluded citations

Records excluded during full-text screening of primary search results n=246 (Stage 2c)

Reasons for exclusion	
Exclude on age	3
Exclude on country	3
Exclude on intervention	45
Exclude on outcomes	71
Exclude on relevant poster, conference abstract, trial protocol, systematic review	66
Exclude on study design	53
Exclude on target group	1
Exclude on unsourceable	4
Total excluded	246

Exclude on age (n=3)

1. Lattimer V, Sassi F, George S, et al. Cost analysis of nurse telephone consultation in out of hours primary care: evidence from a randomised controlled trial. BMJ 2000;320:1053–7.https://doi.org/10.1136/bmj.320.7241.1053 (accessed 8 Dec 2023).
2. Marklund B, Ström M, Månsson J, et al. Computer-supported telephone nurse triage: an evaluation of medical quality and costs. J Nurs Manag 2007;15:180–7.https://doi.org/10.1111/j.1365-2834.2007.00659.x (accessed 8 Dec 2023).
3. North F, Odunukan O, Varkey P. The value of telephone triage for patients with appendicitis. J Telemed Telecare 2011;17:417–20.https://doi.org/10.1258/jtt.2011.110301 (accessed 8 Dec 2023).

Exclude on country (n=3)

1. Chow K-M, Law M-C, Szeto C-C, et al. Telephone Triage in Peritoneal Dialysis Population. Hong Kong J Nephrol 2008;10:64–8.https://doi.org/10.1016/S1561-5413(08)60023-X (accessed 8 Dec 2023).
2. Frid AS, Ratti MFG, Pedretti A, et al. Teletriage Pilot Study (Strategy for Unscheduled Teleconsultations): Results, Patient Acceptance and Satisfaction. Stud Health Technol Inform 2020;270:776–80.https://doi.org/10.3233/SHTI200266
3. Gimenez RM. Triagem remota de pacientes baseada em aplicativo para reduzir filas em unidades de saúde [Application-based remote patient triage to reduce queues at health care facilities]. 2022.http://repositorio.utfpr.edu.br/jspui/handle/1/28833

Excluded on intervention (n=45)

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5. Brunetti ND, Di Pietro G, Aquilino A, et al. Pre-hospital electrocardiogram triage with tele-cardiology support is associated with shorter time-to-balloon and higher rates of timely reperfusion even in rural areas: data from the Bari- Barletta/Andria/Trani public emergency medical service 118 registry on primary angioplasty in ST-elevation myocardial infarction. Eur Heart J Acute Cardiovasc Care 2014;3:204–13.https://doi.org/10.1177/2048872614527009 (accessed 29 Nov 2023).
6. Caceres JA, Adil MM, Jadhav V, et al. Diagnosis of stroke by emergency medical dispatchers and its impact on the prehospital care of patients. J Stroke Cerebrovasc Dis 2013;22:e610-614.https://doi.org/10.1016/j.jstrokecerebrovasdis.2013.07.039 (accessed 29 Nov 2023).
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Exclude on outcomes (n=71)

1. Adrian-Lancelle M, Moreau D, Trinh-Duc A, *et al.* Analyse de la satisfaction des usagers du Samu 47 (Lot-et-Garonne) sur leur prise en charge dans le cadre de l'aide médicale urgente (AMU). *Ann Fr Med Urgence* 2022;12:355–63.https://doi.org/10.3166/afmu-2022-0447 (accessed 8 Dec 2023).
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Exclude on target group (n=1)

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Exclude on unsourceable (n=4)

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Records excluded during data extraction of included primary search results n= 27 (Stage 3)

Reason for exclusion	Number
Exclude on age	8
Exclude on intervention	1
Exclude on outcomes	1

Exclude on study design: no validated tool	9
Exclude on study design: not system surveillance	3
Exclude on study design: secondary triage	1
Exclude on study design: self selection	4

Exclude on age (n=8)

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Exclude on intervention (n=1)

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Exclude on outcomes (n=1)

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Exclude on study design: no validated tool (n=9)

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Records excluded during full-text screening of supplementary search results n=160 (Stage 5)

Code	Count
Exclude on age	3
Exclude on country	2
Exclude on intervention	82
Exclude on outcomes	24
Exclude on relevant poster, conference abstract, trial protocol, SR	1
Exclude on study design	40
Exclude: already screened from first searches	3
Exclude: unsourceable	5

Exclude on age (n=3)

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Exclude on relevant poster, conference abstract, trial protocol, Systematic review (n=1)

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Exclude: already screened from first searches (n=3)

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Exclude: unsourceable (n=5)

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Records excluded during full-text screening of supplementary search results n=4 (Stage 6)

Code	Count
EXCLUDE on outcomes	2
EXCLUDE on study design: not system surveillance	1
EXCLUDE on duplicate	1

Exclude on outcomes (n=2)

1. Andersen MS, Johnsen SP, Sørensen JN, *et al.* Implementing a nationwide criteria-based emergency medical dispatch system: A register-based follow-up study. *Scand J Trauma Resusc Emerg Med* 2013;21:53.https://doi.org/10.1186/1757-7241-21-53 (accessed 5 Jan 2024).
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Exclude on duplicate (n=1)

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Appendix D Cochrane risk-of-bias assessment

Outcomes (Javaud et al. 2018)	Domains						
	1a. Risk of bias arising from the randomisation process	1b. Risk of bias arising from the timing of identification or recruitment of participants in a cluster-randomised trial	2. Risk of bias due to deviations from the intended interventions (effect of assignment to intervention)	3. Risk of bias due to missing outcome data	4. Risk of bias in measurement of the outcome	5. Risk of bias in selection of the reported result	Overall risk of bias
Therapy at home (triage disposition)	Low	Low	Low	Low	Low	Low	Low
Hospital admission	Low	Low	Low	Low	Low	Low	Low
ICU admission	Low	Low	Low	Low	Low	Low	Low
Intubations	Low	Low	Low	Low	Low	Low	Low
Mortality	Low	Low	Low	Low	Low	Low	Low

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Appendix E NHLBI quality assessment

Item	Eastwood *et al.* (2017)	Engelen *et al.* (2023)	Engelitjes *et al.* (2020)	Graverson *et al.* (2023)	Hodgins *et al.* (2022)	Inokuchi *et al.* (2022)	Kukulka *et al.* (2020)	LeClair *et al.* (2023)	Lehm *et al.* (2017)	Lewis *et al.* (2021)	Marincowitz *et al.* (2022)	Sax *et al.* (2018)	Spangler *et al.* (2020)
1. Was the research question or objective in this paper clearly stated?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
2. Was the study population clearly specified and defined?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Was the participation rate of eligible persons at least 50%?	Yes	Yes	N/R	Yes	Yes	Yes	Yes	Yes	N/A	Yes	Yes	Yes	N/A
4A. Were all the subjects selected or recruited from the same or similar populations (including the same time period)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4B. Were inclusion and exclusion criteria for being in the study prespecified and applied uniformly to all participants?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5A. Was a sample size justification, power description, or variance	No	Yes	No	Yes	No	No	No	Yes	No	No	Partial yes	No	No

Item	Eastwood *et al.* (2017)	Engelen *et al.* (2023)	Engelitjes *et al.* (2020)	Graverson *et al.* (2023)	Hodgins *et al.* (2022)	Inokuchi *et al.* (2022)	Kukulka *et al.* (2020)	LeClair *et al.* (2023)	Lehm *et al.* (2017)	Lewis *et al.* (2021)	Marincowitz *et al.* (2022)	Sax *et al.* (2018)	Spangler *et al.* (2020)
and effect estimates provided?													
5B. Was a description of variance provided?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	N/A	N/A	Yes	Yes	Yes
6. For the analyses in this paper, were the exposure(s) of interest measured prior to the outcome(s) being measured?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Was the timeframe sufficient so that one could reasonably expect to see an association between exposure and outcome if it existed?	Yes	N/R	N/R	N/A	Yes	N/R	N/R	N/R	Yes	Yes	Yes	Yes	Yes
8. For exposures that can vary in amount or level, did the study examine different levels of the exposure as related to the outcome (e.g., categories of exposure, or exposure measured as continuous variable)?	N/A	Partial yes	No	N/A	N/A	N/A	N/A	Yes	No	Yes	No	No	N/A

Item	Eastwood *et al.* (2017)	Engelen *et al.* (2023)	Engelitjes *et al.* (2020)	Graverson *et al.* (2023)	Hodgins *et al.* (2022)	Inokuchi *et al.* (2022)	Kukulka *et al.* (2020)	LeClair *et al.* (2023)	Lehm *et al.* (2017)	Lewis *et al.* (2021)	Marincowitz *et al.* (2022)	Sax *et al.* (2018)	Spangler *et al.* (2020)
9. Were the exposure measures (independent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
10. Was the exposure(s) assessed more than once over time?	N/A	N/A	N/A	N/A	N/A	N/A	No	N/A	No	No	N/A	No	N/A
11. Were the outcome measures (dependent variables) clearly defined, valid, reliable, and implemented consistently across all study participants?	Yes	Yes	Partial yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
12. Were the outcome assessors blinded to the exposure status of participants?	N/A	N/R	N/A	Yes	N/A	N/A	N/A	N/R	N/A	N/A	N/A	N/A	N/A
13. Was loss to follow-up after baseline 20% or less?	Not reported	No	Yes	Yes	Yes	Yes	Yes	No	No	Yes	Yes	N/R	No

Item	Eastwood *et al.* (2017)	Engelen *et al.* (2023)	Engelitjes *et al.* (2020)	Graverson *et al.* (2023)	Hodgins *et al.* (2022)	Inokuchi *et al.* (2022)	Kukulka *et al.* (2020)	LeClair *et al.* (2023)	Lehm *et al.* (2017)	Lewis *et al.* (2021)	Marincowitz *et al.* (2022)	Sax *et al.* (2018)	Spangler *et al.* (2020)
14. Were key potential confounding variables measured and adjusted statistically for their impact on the relationship between exposure(s) and outcome(s)?	No	Yes	No	Yes	Yes	Yes	No	Yes	No	No	Yes	Yes	Yes
NHBLI sore	2.5	4.0	3.0	5.0	4.5	4.5	3.5	4.0	2.5	3.5	4.75	3.5	3.5
NHLBI rating	Low	High	Moderate	High	High	High	High	High	Low	High	High	High	High

Appendix F Table of characteristics

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Specific triage services														
Engeltjes *et al.* (2021)	To determine the diagnostic and external validity of a Dutch obstetric telephone triage system in obstetric emergency care.	Prospective observational study	Surveillance system	Pregnant women	Four hospitals in the Netherlands	983	Mean age: 31 years (standard deviation (SD): 5 years)	100	Based on hospital (10–18 months)	Follow-up in hospital and later clinical follow-up	Safety: Undertriage; sensitivity and specificity, positive predictive value (PPV), negative predictive value (NPV) Effectiveness: Triage dispositions; overtriage	No	Subsequent clinical follow-up data missing for 1% of calls (n=12 out of 983 calls); calls triaged to self-care were excluded from analysis.	No reported exclusion of repeat callers

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Kukulka *et al.* (2020)	To expand diagnostic measures to telemedicine by training nurses to administer the single-breath count test over the telephone, allowing for triage and early recognition of myasthenia gravis exacerbations.	Retrospective single-centre review of a pilot study	Surveillance system	Myasthenia gravis patients	Neurology clinic in Missouri, United States of America (USA)	25 patients (45 calls)	Mean age: 42.92 years (SD: 18.46 years)	60	1 year	Follow-up in hospital	Safety: Sensitivity and specificity, PPV Effectiveness: Emergency department (ED) presentation; overtriage; case resolution	None declared	No reported missing data	45 calls by 25 unique patients examined (repeat calls included)

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Javaud *et al.* (2018)	To determine if a telephone care-management strategy would reduce hospital admissions during hereditary angioedema attacks in comparison with usual practice.	Cluster-randomised multicentre prospective trial	Cluster randomised controlled trial	Patients with hereditary angioedema	Eight specialist centres for hereditary angioedema in France	200	Control mean age: 43 years (SD: 16 years) Intervention mean age: 41 years (SD: 16 years)	63	3 years, 4 months	SOS-hereditary angioedema (SOS-HAE) versus usual care Follow-up in hospital; hospital reports	Safety: Admissions; intensive care unit (ICU) admissions; mortality Effectiveness: ED visits; triage dispositions	No	2% (n=4 out of 200 patients) lost to follow-up (n=2 out of 100 in intervention group, n=2 out of 100 in control group).	200 unique patients in trial (repeat calls included but not logged)

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
General triage services														
Eastwood *et al.* (2017)	To investigate the appropriateness of the ED presentation of cases following secondary telephone triage by the Referral Service.	Pragmatic retrospective cohort study	Surveillance system	Secondary referral of cases classified as low acuity when calling the Australian emergency telephone number	Melbourne, Australia	103,768	Not reported for all. Median age by triage disposition for cases that presented at ED: emergency ambulance: 60 years; non-emergency ambulance: 70 years; self-present at ED: 41 years; alternative service providers: 59 years; self-care: 47 years	53	2 years, 10 months	Follow-up in hospital	Safety: Admissions; triage level on presentation to ED (suitability) Effectiveness: ED presentations; triage dispositions; case resolution	None declared	84.1%n= (n=103,768 out of 123,458 calls) of all cases triaged by the service had service case records available. There was also further uncalculated loss to follow-up in relation to ED presentations and hospital admissions.	No reported exclusion of repeat callers

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Graversen *et al.* (2023)	To investigate the risk of undertriage and overtriage in high-risk telephone calls to out-of-hours primary care (OOH-PC) in Denmark.	A natural quasi-experimental cross-sectional study	Surveillance system	High-risk callers and a random sample of all callers	Two OOH-PC services in Denmark	Nurse-led triage: random sample: 407; high-risk calls: 199 General practitioner (GP)-led triage: random sample: 399; high-risk calls: 206	No mean reported. High-risk calls limited to those aged 30 years and over, and 33% were aged 60 years and over. Random calls: <18 years: 36.5%; 18–29 years: 21.0%; 30–59 years: 27.5%; ≥60 years: 15.0%	60	14–15 days	Validated tool (Assessment of Quality in Telephone Triage); nurse versus GP triage models	Safety: Accuracy Effectiveness: Overtriage	No	Excluded 6% of randomly selected calls (n=47 out of 853 calls) and 7% of high-risk calls (n=30 out of 435 calls) as calls assigned 'not applicable', as assessing accuracy of triage was reported to not be possible (e.g. insufficient information was available) or to not be relevant.	No reported exclusion of repeat callers

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Hodgins *et al.* (2022)	To assess the effectiveness of telephone triage in the United Kingdom (UK) in identifying patients needing urgent attention by examining pathways of care and hospital admission outcomes in a young adult population calling National Health Service (NHS) 24 with chest pain.	Retrospective population study	Surveillance system	All callers aged 15–34 years with chest pain	Scotland	97,619	No mean reported. Only 15–34-year-olds included (15–19 years: 19.6%; 20–24 years: 30.3%; 25–29 years: 27.2%; 30–34 years: 23.0%)	63	3 years	Follow-up using linked national medical records	Safety: Admissions; sensitivity and specificity, PPV, NPV; mortality Effectiveness: Triage dispositions; case resolution; healthcare utilisation	No	Triage disposition data missing for 5.1% of callers (n=5,203 out of 102,822 total callers)	No reported exclusion of repeat callers

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Inokuchi *et al.* (2022)	To predict undertriage based on information obtained by telephone using machine learning models and identify the predictors of risk factors associated with undertriage.	Retrospective cohort study	Surveillance system	Orange- and yellow-level callers to an after-hours house-call (AHHC) service	Tokyo, Japan	19,114	Mean age: 38.4 years (SD: 16.6 years)	43	2 years, 3 months	Doctor follow-up at house call	Safety: Undertriage	Yes	5.3% (n=2,373 out of 44,982 total calls) excluded due to missing data on chief complaint categories. Follow-up data indicating undertriage were missing for 1.9% of included calls (n=363 out of 19,114 calls).	No reported exclusion of repeat callers

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Lewis *et al.* (2021)	To measure attendance at ED (and subsequent hospital admissions) up to 2 days after an NHS 111 call, and whether this is in line with the recommendations given by NHS 111 staff.	Exploratory investigation	Surveillance system	All NHS 111 callers	Yorkshire and Humber regions in the UK	3,614,915	Not reported for the whole sample (all callers were aged over 16 years).	Not reported	4 years	Follow-up in hospital	Safety: Admissions; accuracy (percentage deemed urgent versus non-urgent on arrival at ED) Effectiveness: Triage dispositions; ED presentations; overtriage (percentage deemed urgent versus non-urgent on arrival at ED)	No	0.4% missing data (n=16,154 out of 3,631,069 calls)	No reported exclusion of repeat callers

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Marincowitz *et al.* (2022)	1. To assess how accurately NHS 111 telephone services identified those who suffered an adverse outcome when they needed an emergency response. 2. To identify any factors that may have affected the accuracy of	Observational cohort study	Surveillance system	Callers with coronavirus disease 2019 (COVID-19) symptoms	Yorkshire and Humber, Bassetlaw, North Lincolnshire, and North East Lincolnshire regions in the UK	40,261	Mean age: 48.4 years Median age: 47 years (range: 32–61 years)	56	3.5 months	Follow-up in hospital and with GP. NHS Digital used to link data.	Safety: Serious adverse events (sensitivity and specificity, NPV, PPV) Effectiveness: ED presentations; triage dispositions	No	Prior to exclusion of repeat callers, 0.1% (n=76 out of 58,784 calls) of records were unlinkable; after exclusion of repeat callers, a further 0.8% (n=313 out of 40,574 calls) were excluded as they were missing triage disposition data leaving the included 40.261 final study population. Within the included sample, there was also however a discrepancy of 896	40,261 unique patients (6,222 excluded as 'multiple calls from single patient or excluded patients')

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
	telephone triage.												participants when adding up each triage disposition separately compared with the total number of included patients indicated.	

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Sax *et al.* (2018)	To compare venue-of-care recommendations, patients' care-seeking behaviour, ED use, and patient outcomes for calls directed by physicians compared with nurses	Retrospective population-based cohort study of a natural experiment	Surveillance system	Callers with chest pain aged 36 years and over	Northern California, USA	29,673 (22,630 after propensity matching) nurse-directed and physician-directed calls	No mean reported. Minimum age in the study was 36 years prior to propensity matching. Physician-directed calls: 36–49 years: 34%; 50–64 years: 36%; 65–74 years: 17%; ≥75 years: 13% Nurse-directed calls: 36–49 years: 30%; 50–64 years: 36%; 65–74 years: 17%; ≥75 years: 18%	63	1 year	Follow-up in hospital; linked data used from databases	Safety: Admissions; mortality Effectiveness: Triage dispositions	Yes	Data were missing for 6.29% (n=2,466 out of 39,197 callers) who were unlinkable due to non-continuous Kaiser Permanente health plan membership. Pregnant women (n=119), non-English-language callers (n=8,115), and callers with upper respiratory infection complaints or trauma victims (n=241) were also excluded.	Patients who called more than once (in the 30 days before or after the index call) were excluded (18%; n=7,058 out of 39,197 callers)

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Engelen (2023)	To assess the relationship between overruling of the Netherlands Triage Standard urgency by the triage nurse and the final diagnosis of transient ischaemic attack or stroke in people who call the OHS-PC service for symptoms suspected of being a transient ischaemic attack or stroke.	Described as part of an observational study	Surveillance system	Callers with symptoms suspected of being a transient ischaemic attack or stroke	Nine OHS-PC services in the vicinity of the city of Utrecht in the Netherlands	1,955	Mean age: 68.9 years (SD: 18.4 years)	56	3 years	Clinical follow-up via GP (final diagnosis) Overruled urgencies compared with tool-assigned urgency	Safety: Accuracy (sensitivity and specificity) Effectiveness: Triage dispositions	None declared	For 2 out of 1,955 calls data were missing on whether overruling had occurred or not. The author also reported that 29.6% of the random subsample of calls were excluded as they were missing final diagnosis data but is unknown what number of calls this represented as the author did not report the size of the random subsample taken.	No reported exclusion of repeat callers

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Leclair (2023)	To evaluate the relation between consulting the supervising GP and: (i) the urgency allocation, and (ii) the diagnosis of acute coronary artery syndrome in patients calling the OHS-PC service with chest discomfort.	Described as part of an observational study	Surveillance system	Callers with symptoms suggestive of acute coronary artery syndrome	Nine OHS-PC services in the vicinity of the city of Utrecht in the Netherlands	2,195	Mean age: 59.1 years (SD: 19.5 years)	56	3 years	Clinical follow-up via GP (final diagnosis) Urgencies when GP consulted Overruled urgencies versus tool-assigned urgency	Safety: Accuracy; undertriage Effectiveness: Triage dispositions	None declared	Number of calls excluded due to lack of GP participation not reported. An additional 40% (n=1,435 out of 3,630) were later lost to follow-up due to unknown diagnosis.	No reported exclusion of repeat callers

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Lehm *et al.* (2017)	To describe the characteristics of the Level E patients in the Central Denmark Region and follow up following 112 call.	Retrospective follow-up study	Surveillance system	Level E patients	Emergency medical communication centre in Aarhus, Denmark	4,962	Median age: 47 years (interquartile range: 24.3–67.7 years). No mean given.	47	1 year	Follow-up in hospital, with GP, and for mortality through Danish registries	Safety: Mortality; admissions Effectiveness: Triage dispositions (within Level E); ED attendances; healthcare utilisation	No	Data missing for 47.2% of calls (n=5,401 out of 11,438 calls) due to invalid unique civil registration numbers and for 11.2% of unique patients (n=556 out of 4,962 patients) due to missing disposition data.	9.4% of repeated calls excluded throughout (n=1,075 out of 11,438 calls)

Author (year)	Research question	Author-assigned study design	HRB-assigned study design	Study population(s)	Location	Sample size	Age (mean or median)	Female (%)	Study length	Study comparator(s)	Outcome(s) reported	Industry funding	Missing data, including data linkage issues	Calls/unique patients (treatment of repeat callers)
Spangler *et al.* (2020)	To propose and evaluate criteria for use within the global trigger tool framework to identify triage errors by emergency medical dispatch nurses.	An observational study	Surveillance system	Callers who are directed to non-emergency care	Two emergency medical dispatch centres in Sweden	1,089 calls	Median age: 61 years (range: 59–64 years)	53	4 months	Follow-up in hospital	Safety: Admissions; specialist interventions above primary care level Effectiveness: ED presentations	No	Data missing for 35.8% of calls due to data entry issues (2.1%; n=36 out of 1,696 calls) and missing personal identification numbers (33.7%; n=571 out of 1,696 calls)	Repeat calls were included apart from a sensitivity analysis on ED visits within 7 days, which was limited to 903 unique patients out of 1,089 included calls.

Appendix G Feasibility assessment for meta-analysis

Outcomes		Number of studies	Quality assessment	Population, intervention, comparator, outcome(s), time frame, and study design (PICOTS) assessment (clinical and methodological diversity)					Meta-analysis feasibility decision
				Population	Intervention/ comparator	Outcome	Timeframe	Study design	
SPECIFIC TRIAGE SERVICES									
SAFETY									
Mortality	Within 12 months	Javaud *et al.* 2018	Low	People with hereditary angioedema	Phone triage/ usual care	No. intubations	12 months	Cluster RCT	Not feasible: Single study
Admissions	Hospital admissions	1. Javaud *et al.* 2018 2. Engeltjes *et al.* 2021	1. Low 2. Moderate	1. People with hereditary angioedema 2. Pregnant women	1. Phone triage/ usual care 2. Phone triage/ clinical follow-up	1. Hospital and ICU admissions 2. Hospital admissions	1. Two years 2. Unknown	1. Cluster RCT 2. Surveillance system	Not feasible: Quality assessment, population, outcome measurement, and timeframes are too different
Undertriage	Face to face assessment at hospital	1. Engeltjes *et al.* 2021; 2. Kukulka *et al.* 2020	1. Moderate 2. High	1. Pregnant women 2. Mysathenia gravis patients	1. Phone triage/ clinical follow-up 2. Phone triage/ clinical follow-up	1. ED diagnosis 2. Hospital assessment	1. Unknown 2. Unknown	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessment, population, and outcome measurement are too different
	Accuracy based on clinical follow-up	Engeltjes *et al.* 2021	Moderate	Pregnant women	Phone triage/ clinical follow-up	Accuracy	Not specified	Surveillance system	Not feasible: Single study
	Intubations	Javaud *et al.* 2018	Low	People with hereditary angioedema	Phone triage/ usual care	No. intubation	Not specified	Cluster RCT	Not feasible: Single study
EFFECTIVENESS									
Triage dispositions	Triage dispositions (Surveillance system studies)	1. Engeltjes *et al* 2021; 2. Kukulka *et al.* 2020	1. Moderate 2. High	1. Pregnant women 2. Mysathenia gravis patients	1. Phone triage/ clinical follow-up	1. ED diagnosis 2. Hospital assessment	1. Unknown 2. Unknown	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessment, population, and outcome

Outcomes		Number of studies	Quality assessment	Population, intervention, comparator, outcome(s), time frame, and study design (PICOTS) assessment (clinical and methodological diversity)					Meta-analysis feasibility decision
				Population	Intervention/ comparator	Outcome	Timeframe	Study design	
					2. Phone triage/ clinical follow-up				measurement are too different
	Triage dispositions (RCTs)	Javaud *et al.* 2018	Low	People with hereditary angioedema	Phone triage/ usual care	Triage disposition	Two years	Cluster RCT	Not feasible: Single study
ED attendances	ED attendances	Kukulka *et al.* 2020	High	Mysathenia gravis patients	Phone triage/ clinical follow-up	ED attendances	Not specified	Surveillance system	Not feasible: Single study
Overtriage	Overtriage	1. Engeltjes *et al.* 2021; 2. Kukulka *et al.* 2020	1. Moderate 2. High	1. Pregnant women 2. Mysathenia gravis patients	1. Phone triage/ clinical follow-up 2. Phone triage/ clinical follow-up	1. ED diagnosis 2. Hospital assessment	1. Unknown 2. Unknown	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessment, population, and outcome measurement are too different
GENERAL TRIAGE SERVICES									
SAFETY									
Mortality	Same day mortality	Lehm *et al.* 2017							Not feasible: Single study
	7-day mortality	1. Hodgins *et al.* 2022; 2. Lehm *et al.* 2017	1. High 2. Low	1. Young adults with chest pain 2. Level E patients	1. Phone triage/ overall mortality 2. Phone triage/ overall mortality	1. Mortality 2. Mortality	1. 7 days 2. 7 days	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessment and populations are too different
	30-day mortality	1. Lehm *et al.* 2017; 2. Sax *et al.* 2018	1. Low 2. High	1. Level E patients 2. Chest pain ≥36 years of age	1. Phone triage/ overall mortality 2. Phone triage/ overall mortality	1. Mortality 2. Mortality	1. 30 days 2. 30 days	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessment and populations are too different
Admissions	Within 1 day	1. Lehm *et al.* 2017; 2. Spangler *et al.* 2020	1. Low 2. High	1. Level E patients	1. Phone triage/ linked data 2. Phone triage/ linked data	1. Hospital admissions 2. Hospital admissions	1. 1 day 2. 1 day	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessment and populations are too different

Outcomes		Number of studies	Quality assessment	Population, intervention, comparator, outcome(s), time frame, and study design (PICOTS) assessment (clinical and methodological diversity)					Meta-analysis feasibility decision
				Population	Intervention/ comparator	Outcome	Timeframe	Study design	
				2. Non-emergency patients					
	Within 2 days	Eastwood *et al.* 2017	Low	Less serious patients	Phone triage/ ED triage	Hospital admission within two days	Two days	Surveillance system	Not feasible: Single study
	Within 3 days	1. Spangler *et al.* 2020; 2. Lewis *et al.* 2021	3. High 4. High	1. Non-emergency patients 2. General patients	1. Phone triage/ linked data 2. Phone triage/ linked data	1. Hospital admissions 2. Hospital admissions	1. 3 days 2. 3 days (48 hours + 1 night)	1. Surveillance system 2. Surveillance system	Not feasible: Populations are too different
	Within 7 days	1. Hodgins *et al.* 2022; 2. Lehm *et al.* 2017; 3. Spangler *et al.* 2020	1. High 2. Low 3. High	1. Young adults with chest pain 2. Level E patients 3. Non-emergency patients	1. Phone triage/ linked data 2. Phone triage/ linked data 3. Phone triage/ linked data	1. Hospital admissions 2. Hospital admissions 3. Hospital admissions	1. 7 days 2. 7 days 3. 7 days	1. Surveillance system 2. Surveillance system 3. Surveillance system	Not feasible: Quality assessments and populations are too different
	Within 30 days	Lehm *et al.* 2017	Low	Level E patients	Phone triage/ later assessments	Hospital admissions	30 days	Surveillance system	Not feasible: Single study
Accuracy: Remote triage assessment compared with face-to-face assessment	Within 6 hours	Inokuchi *et al.* 2022	High	General patients with mid-level dispositions	Phone triage/face-to-face assessment	Accuracy	6 hours	Surveillance system	Not feasible: Single study
	Within 1 day	Spangler *et al.* 2020	High	Non-emergency patients	Phone triage/ linked data	Accuracy	1 day	Surveillance system	Not feasible: Single study
	Within 2 days	1. Lewis *et al.* 2021; 2. Eastwood *et al.* 2017	1. High 2. Low	1. General patients 2. Less serious patients	1. Phone triage/ non-urgent ED triage 2. Phone triage/ ED triage	1. Undertriage based on face-to-face assesment 2. Undertriage based on face-to-face assesment	1. 2 days 2. 2 days	1. Surveillance system 2. Surveillance system	Not feasible : Quality assessments and populations are too different

Outcomes		Number of studies	Quality assessment	Population, intervention, comparator, outcome(s), time frame, and study design (PICOTS) assessment (clinical and methodological diversity)					Meta-analysis feasibility decision
				Population	Intervention/ comparator	Outcome	Timeframe	Study design	
	Within 3 days	Spangler *et al.* 2020	High	Non-emergency patients	Phone triage/ linked data	Disposition accuracy within one day	One day	Surveillance system	Not feasible: Single study
	Within 7 days	1. Spangler *et al.* 2020; 2. Hodgins *et al.* 2022	1. High 2. High	1. Non-emergency patients 2. Young adults with chest pain	1. Phone triage/ specialist intervention at ED 2. Phone triage/ requiring urgent treatment at ED	1. Undertriage based on face-to-face assesment 2. Undertriage based on face-to-face assesment	1. 7 days 2. 7 days	1. Surveillance system 2. Surveillance system	Not feasible: Populations too different
Accuracy: Remote triage assessment compared with final diagnosis	Final diagnosis	1. Engelen *et al.* 2023; 2. Leclair *et al.* 2023	1. High 2. High	1. TIA/Stroke patients 2. Acute coronary syndrome	1. Phone triage/ GP diagnosis 2. Phone triage/ GP diagnosis	1. Final diagnosis 2. Final diagnosis	1. Unknown 2. Unknown	1. Surveillance system 2. Surveillance system	Not feasible: Populations too different
Accuracy: Remote triage assessment based on serious adverse events	Serious adverse events	Marincowitz *et al.* 2022	High	People with COVID-19 symptoms	Phone triage/ later follow-up	Accuracy	3 days, 7 days, 30 days	Surveillance system	Not feasible: Single study
Accuracy: Remote triage assessment based on a validated tool	Based on a validated tool	Graversen *et al.* 2023	High	General callers	Phone triage/ Assessment of Quality in Telephone Triage tool	Accuracy	Not specified	Surveillance system	Not feasible: Single study
EFFECTIVENESS									
Triage dispositions	Triage dispositions	1. Hodgins *et al.* 2022; 2. Marincowitz *et al.* 2022; 3. Sax *et al.* 2018; 4. Engelen *et al.* 2023; 5. LeClair *et al.* 2023;	1. High 2. High 3. High 4. High 5. High	1. Young adults with chest pain 2. COVID-19 symtpoms	1. Phone triage/ no comparator 2. Phone triage/ no comparator	1. Triage dispositions 2. Triage dispositions	1. 3 years 2. 3.5 months 3. 1 year 4. 3 years 5. 3 years	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessments, populations and

Outcomes		Number of studies	Quality assessment	Population, intervention, comparator, outcome(s), time frame, and study design (PICOTS) assessment (clinical and methodological diversity)					Meta-analysis feasibility decision
				Population	Intervention/ comparator	Outcome	Timeframe	Study design	
		6. Eastwood *et al.* 2017; 7. Lehm *et al.* 2017; 8. Lewis *et al.* 2021; 9. Spangler *et al.* 2020	6. Low 7. Low 8. High 9. High	3. Chest pain ≥36 years of age 4. TIA/Stroke patients 5. Acute coronary syndrome 6. Less serious patients 7. Level E patients 8. General patients 9. Non-emergency patients	3. Phone triage/ no comparator 4. Phone triage/ no comparator 5. Phone triage/ no comparator 6. Phone triage/ no comparator 7. Phone triage/ no comparator 8. Phone triage/ no comparator 9. Phone triage/ no comparator	3. Triage dispositions 4. Triage dispositions 5. Triage dispositions 6. Triage dispositions 7. Triage dispositions 8. Triage dispositions 9. Triage dispositions	6. 2 years, 10 months 7. 1 year 8. 4 years 9. 4 months	3. Surveillance system 4. Surveillance system 5. Surveillance system 6. Surveillance system 7. Surveillance system 8. Surveillance system 9. Surveillance system	timeframes are too different
ED attendances	Within 1 day	1. Lehm *et al.* 2017; 2. Spangler *et al.* 2020	1. Low 2. High	1. Level E patients 2. Non-emergency patients	1. Phone triage/ later ED attendance 2. Phone triage/linked data	1. ED attendances 2. ED attendances	1. 1 day 2. 1 day	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessment and populations are too different
	Within 2 days	1. Lewis *et al.* 2021; 2. Eastwood *et al.* 2017	1. High 2. Low	1. General patients 2. Less serious patients	1. Phone triage/non-urgent ED triage 2. Phone triage/ ED triage	1. Undertriage based on face-to-face assesment 2. Undertriage based on face-to-face assesment	1. 2 days 2. 2 days	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessments and populations are too different
	Within 3 days	Spangler *et al.* 2020	High	Non-emergency patients	Phone triage/ linked data	ED attendances	3 days	Surveillance system	Not feasible: Single study
	Within 7 days	1. Lehm *et al.* 2017; 2. Spangler *et al.* 2020	1. Low 2. High	1. Level E patients	1. Phone triage/ later ED attendance	1. ED attendances	1. 7 days 2. 7 days	1. Surveillance system	Not feasible: Quality assessment

Outcomes		Number of studies	Quality assessment	Population, intervention, comparator, outcome(s), time frame, and study design (PICOTS) assessment (clinical and methodological diversity)					Meta-analysis feasibility decision
				Population	Intervention/ comparator	Outcome	Timeframe	Study design	
				2. Non-emergency patients	2. Phone triage/ linked data	2. ED attendances		2. Surveillance system	and populations are too different
	Within 30 days	Lehm *et al.* 2017	Low	Level E patients	Phone triage/ later ED attendance	Hospital admissions	30 days	Surveillance system	Not feasible: Single study
Overtriage	At entry	Graverson *et al.* 2023	High	General callers	Phone triage/ Assessment of Quality in Telephone Triage tool	Overtriage	Not specified	Surveillance system	Not feasible: Single study
	Within 2 days	Lewis *et al.* 2021	High	General callers	Phone triage/ face-to-face assessment	Overtriage	2 days	Surveillance system	Not feasible: Single study
Case resolution	Within 1 day	Hodgins *et al.* 2022	High	Young adults with chest pain	Phone triage/ later follow-up	Case resolution	1 day	Surveillance system	Not feasible: Single study
Healthcare utilisation	Within 1 day	1. Hodgins *et al.* 2022; 2. Lehm *et al.* 2017	1. High 2. Low	1. Young adults with chest pain 2. Level E patients	1. Phone triage/ later follow-up 2. Phone triage/later follow-up	1. Healthcare utilisation 2. Healthcare utilisation	1. 1 day 2. 1 day	1. Surveillance system 2. Surveillance system	Not feasible: Quality assessment and populations are too different

Appendix H Grading of Recommendations, Assessment, Development and Evaluations

Outcomes		Author	Single study	Downgrades						Upgrades			Certainty of the evidence
				Study design	Risk of bias	Inconsistency of results	Indirectness of evidence	Imprecision	Publication bias	Large magnitude of effect	Dose-gradient response	Effect of plausible residual confounding	
SPECIFIC TRIAGE SERVICES													
SAFETY													
Mortality	Within 12 months	Javaud *et al.* 2018	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
Admissions	ICU admissions	Javaud *et al.* 2018	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	Hospital admissions	Javaud *et al.* 2018	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	Hospital admissions	Engeltjes *et al.* 2021	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
Undertriage	Face to face assessment at hospital	Engeltjes *et al.* 2021; Kukulka, Gummi, and Govindarajan 2020	Yes	-4	-1	0	-2	-1	-1	0	0	0	Very Low
	Accuracy based on clinical follow-up	Engeltjes *et al.* 2021	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	Intubations	Javaud *et al.* 2018	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
EFFECTIVENESS													
Triage dispositions	Triage dispositions (Surveillance system studies)	Engeltjes *et al.* 2021; Kukulka *et al.* 2020	No	-4	-1	0	-2	-2	-1	0	0	0	Very Low
	Triage dispositions (RCTs)	Javaud *et al.* 2018	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
ED attendances	ED attendances	Kukulka, Gummi, and Govindarajan 2020	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low

Outcomes		Author	Single study	Downgrades						Upgrades			Certainty of the evidence
				Study design	Risk of bias	Inconsistency of results	Indirectness of evidence	Imprecision	Publication bias	Large magnitude of effect	Dose-gradient response	Effect of plausible residual confounding	
Overtriage	Overtriage	Engeltjes *et al.* 2021; Kukulka *et al.* 2020	Yes	-4	-1	0	-2	-2	-1	0	0	0	Very Low
GENERAL TRIAGE SERVICES													
SAFETY													
Mortality	Same day mortality	Lehm, Andersen, and Riddervold 2017	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	7-day mortality	Hodgins *et al.* 2022; Lehm, Andersen, and Riddervold 2017	No	-4	-1	0	-2	-1	-1	0	0	0	Very Low
	30-day mortality	Lehm, Andersen, and Riddervold 2017; Sax *et al.* 2018	No	-4	-2	0	-2	-1	-1	0	0	0	Very Low
Admissions	Within 1 day	Lehm, Andersen, and Riddervold 2017; Spangler *et al.* 2020	No	-4	-2	0	-2		-1	0	0	0	Very Low
	Within 2 days	Eastwood *et al.* 2017	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	Within 3 days	Spangler *et al.* 2020; Lewis *et al.* 2021	No	-4	-1	0	-1	-1	-1	0	0	0	Very Low
	Within 7 days	Hodgins *et al.* 2022; Lehm, Andersen, and Riddervold 2017; Spangler *et al.* 2020	No	-4	0	0	-2	-1	-1	0	0	0	Very Low
	Within 30 days	Lehm, Andersen, and Riddervold 2017	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
Accuracy: Remote triage assessment compared with face-to-face assessment	Within 6 hours	Inokuchi *et al.* 2022	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	Within 1 day	Spangler *et al.* 2020	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	Within 2 days	Lewis *et al.* 2021; Eastwood *et al.* 2017	No	-4	-1	0	-1	-1	-1	0	0	0	very low
	Within 3 days	Spangler *et al.* 2020	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	Within 7 days	Spangler *et al.* 2020; Hodgins *et al.* 2022	No	-4	-1	-1	-2	-1	-1	0	0	0	Very Low

Outcomes		Author	Single study	Downgrades						Upgrades			Certainty of the evidence
				Study design	Risk of bias	Inconsistency of results	Indirectness of evidence	Imprecision	Publication bias	Large magnitude of effect	Dose-gradient response	Effect of plausible residual confounding	
Accuracy: Remote triage assessment compared with final diagnosis	Final diagnosis	Engelen 2023; Leclair 2023	No	-4	-1	0	-1	-1	-1	0	0	0	Very Low
Accuracy: Remote triage assessment based on serious adverse events	Serious adverse events	Marincowitz *et al.* 2022	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
Accuracy: Remote triage assessment based on a validated tool	Based on a validated tool	Graversen *et al.* 2023	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
EFFECTIVENESS													
Triage dispositions	Triage dispoitions	Hodgins *et al.* 2022; Marincowitz *et al.* 2022; Sax *et al.* 2018; Engelen *et al.* 2023; LeClair *et al.* 2023; Eastwood *et al.* 2017; Lehm, Andersen, and Riddervold 2017; Lewis *et al.* 2021; Spangler *et al.* 2020	No	-4	-1	0	-2	-2	-1	0	0	0	Very Low
ED attendances	Within 1 day	Lehm, Andersen, and Riddervold 2017; Spangler *et al.* 2020	No	-4	-2	0	-2	-1	-1	0	0	0	Very Low
	Within 2 days	Lewis *et al.* 2021; Eastwood *et al.* 2017	No	-4	-1	0	-1	-1	-1	0	0	0	Very Low
	Within 3 days	Spangler *et al.* 2020	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low

Outcomes		Author	Single study	Downgrades						Upgrades			Certainty of the evidence
				Study design	Risk of bias	Inconsistency of results	Indirectness of evidence	Imprecision	Publication bias	Large magnitude of effect	Dose-gradient response	Effect of plausible residual confounding	
	Within 7 days	Lehm, Andersen, and Riddervold 2017; Spangler *et al.* 2020	No	-4	-2	0	-2	-1	-1	0	0	0	Very Low
	Within 30 days	Lehm, Andersen, and Riddervold 2017	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
Overtriage	At entry	Graverson *et al.* 2023	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
	Within 2 days	Lewis *et al.* 2021	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
Case resolution	Within 1 day	Hodgins *et al.* 2022	Yes	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Very Low
Healthcare utilisation	Within 1 day	Hodgins *et al.* 2022; Lehm *et al.* 2017	No	-4	-1	0	-2	-2	-1	0	0	0	Very Low

Appendix I Included studies

Included studies (14)
Eastwood K, Smith K, Morgans A, *et al.* Appropriateness of cases presenting in the emergency department following ambulance service secondary telephone triage: a retrospective cohort study. *BMJ Open* 2017;7:e016845.
Engelen R. Overruling of the urgency allocation by triage nurses in males and females with symptoms suspected of transient ischemic attack or stroke in out-of-hours primary care. Utrecht, Netherlands: Utrecht University 2023. https://studenttheses.uu.nl/handle/20.500.12932/44455 (accessed 15 Jan 2024).
Engeltjes B, Van Dijk C, Rosman A, *et al.* Validation of Dutch obstetric telephone triage system: a prospective validation study. *Risk Manag Healthc Policy* 2021;14:1907–15.
Graversen DS, Pedersen AF, Christensen MB, *et al.* Factors associated with undertriage and overtriage in telephone triage in Danish out-of-hours primary care: a natural quasi-experimental cross-sectional study of randomly selected and high-risk calls. *BMJ Open* 2023;13:e064999.
Hodgins P, McMinn M, Reed MJ, *et al.* Telephone triage of young adults with chest pain: population analysis of NHS24 calls in Scottish unscheduled care. *Emerg Med J* 2022;39:508–14
Inokuchi R, Iwagami M, Sun Y, *et al.* Machine learning models predicting undertriage in telephone triage. *Ann Med* 2022;54:2990–7.
Javaud N, Fain O, Durand-Zaleski I, *et al.* Specialist advice support for management of severe hereditary angioedema attacks: a multicenter cluster-randomized controlled trial. In: *Reuter, P. Télémédecine et urgences : pertinence de la réponse d'un centre de réception et de régulation des appels*. Paris, France: Université Sorbonne Paris Cité 2018. 93–103. https://www.theses.fr/2018USPCD035 (accessed 15 Jan 2024).
Kukulka K, Gummi RR, Govindarajan R. A telephonic single breath count test for screening of exacerbations of myasthenia gravis: A pilot study. *Muscle Nerve* 2020;62:258–61.
Leclair D. Does involvement of the supervising general practitioner impact urgency allocation and diagnosis of acute coronary artery syndrome in patients with chest discomfort who contact out-of-hours primary care? Utrecht, Netherlands: Utrecht University 2023. https://studenttheses.uu.nl/handle/20.500.12932/43872 (accessed 15 Jan 2024).
Lehm KK, Andersen MS, Riddervold IS. Non-urgent emergency callers: characteristics and prognosis. *Prehosp Emerg Care* 2017;21:166–73.
Lewis J, Stone T, Simpson R, *et al.* Patient compliance with NHS 111 advice: Analysis of adult call and ED attendance data 2013-2017. *PLoS One* 2021;16:e0251362.
Marincowitz C, Stone T, Bath P, *et al.* Accuracy of telephone triage for predicting adverse outcomes in suspected COVID-19: an observational cohort study. *BMJ Qual Saf* Published Online First: 2022.https://doi.org/10.1136/bmjqs-2021-014382 (accessed 15 Jan 2024).
Sax DR, Vinson DR, Yamin CK, *et al.* Tele-triage outcomes for patients with chest pain: comparing physicians and registered nurses. *Health Aff (Millwood)* 2018;37:1997–2004.
Spangler D, Edmark L, Winblad U, *et al.* Using trigger tools to identify triage errors by ambulance dispatch nurses in Sweden: an observational study. *BMJ Open* 2020;10:e035004.

Appendix J Triage services

Author (year)	Name of service	Components (any named tool/system/framework used)	Triageur	Level (national, regional, or local)	Other key features
Specific triage services					
Engeltjes *et al.* (2021)	Dutch obstetric telephone triage system	Implementation of the Dutch obstetric telephone triage system is individually guided with a digital application built into the main hospital's information system which was accessible in the patient's record.	Obstetrical nurses or doctor's assistants (results not separable)	Regional/local	The Dutch obstetric telephone triage system is an evidence-based guideline for obstetric telephone triage and was developed through a multiphase, multicentre study.
Kukulka *et al.* (2020)	No name reported	No computed decision support system reported. Pocket flash cards containing key information were given to staff.	Nurses	Local	The service performed the single-breath count test over the telephone in order to screen for exacerbations of myasthenia gravis.
Javaud *et al.* (2018)	SOS-hereditary angioedema (SOS-HAE) national call centre	No computed decision support system reported	Emergency physicians trained in hereditary angioedema management	National service; regional study	All patients in the intervention arm were given an SOS-HAE card indicating what to do in the case of a severe attack.
General triage services					
Eastwood *et al.* (2017)	The Referral Service	Condition-specific computer-based questioning algorithm (Care Enhanced Call Centre)	Nurses or paramedics (results not separable)	Regional (metropolitan/state-wide)	Initially, calls are made to the emergency dispatch centre and if callers are deemed low acuity, they receive telephone triage from the Referral Service.
Graversen *et al.* (2023)	Out-of-hours primary care (OOH-PC): general practitioner (GP) cooperative (GPC)/Medical Helpline 1813 (MH-1813)	• GPC has no computed decision support system • MH-1813 uses a computed decision support system	GP or nurse (two OOH-PC services using different triage models) (results separable for high-risk patients only)	Regional	• GPC: GPs or GP trainees in their final year of specialty • MH-1813: Nurses who have the option to redirect calls to a physician
Hodgins *et al.* (2022)	National Health Service (NHS) 24	Clinical decision support system (NHS Pathways)	Trained call handlers	National	None
Inokuchi *et al.* (2022)	After-hours house-call (AHHC) service by Fast DOCTOR Ltd.	No computed decision support system reported	Nurses	Regional	The AHHC service sends a doctor (house call) when a patient is triaged as orange or yellow.
Lewis *et al.* (2021)	NHS 111	No computed decision support system reported (however, NHS 111 is known to use decision support software)	Call handlers without clinical backgrounds, with some clinical advisors available to provide support for challenging cases (results not	National call line; regional study	Some clinical advisors are available to provide support for challenging cases.

Author (year)	Name of service	Components (any named tool/system/framework used)	Triageur	Level (national, regional, or local)	Other key features
			separable on this basis)		
Marincowitz *et al.* (2022)	NHS 111	NHS Pathways clinical decision support software as locally implemented in the Yorkshire Ambulance Service NHS Trust	Trained non-clinical call advisor in the first instance, with the option to pass a call on (to a nurse/paramedic or to other specialist clinicians depending on local arrangements) for further assessment.	National call line; regional study	Some clinical advisors are available to provide support for challenging cases.
Sax *et al.* (2018)	Appointment and advice call centre of Kaiser Permanente Northern California	For nurse-directed calls, nurses used an algorithm; direct-to-physician calls involved the physician reviewing all medical records in real time and using their clinical judgement.	Nurses and emergency call centre physicians (results separable; assignment based on wait time)	Regional	Calls are forwarded directly to a physician if certain criteria are met (related to chest pain complaints).
Engelen (2023)	The Netherlands Triage Standard	Semi-automatic decision support tool	Triage nurse (who can consult supervising GP)	Regional	The triage nurse can overrule the urgency level generated by the Netherlands Triage Standard, upgrading or downgrading it (usually done after consulting with the supervising GP).
Leclair (2023)	The Netherlands Triage Standard	Semi-automatic decision support tool	Triage nurse (who can consult supervising GP)	Regional	The triage nurse can overrule the urgency level generated by the Netherlands Triage Standard, upgrading or downgrading it.
Lehm *et al.* (2017)	Emergency medical communication centre (EMCC)	Dispatch software guided by the Danish Index for Emergency Care	Nurses, doctors, or paramedics (healthcare professionals) (results not separable)	Regional	Levels of descending urgency exist (Levels A to E). All callers above Level E get sent an ambulance.
Spangler *et al.* (2020)	Emergency medical dispatch centres	Computerised clinical decision support system used (not used in 30% of cases) (results for admission/assessment outcome not separable)	Nurses	National service; regional study	None