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Service use, clinical outcomes and user experience associated with urgent care services that use telephone-based digital triage: a systematic review

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ABSTRACT

Objective To evaluate service use, clinical outcomes and user experience related to telephone-based digital triage in urgent care.

Design Systematic review and narrative synthesis.

Data sources Medline, Embase, CINAHL, Web of Science and Scopus were searched for literature published between 1 March 2000 and 1 April 2020.

Eligibility criteria for selecting studies Studies of any design investigating patterns of triage advice, wider service use, clinical outcomes and user experience relating to telephone based digital triage in urgent care.

Data extraction and synthesis Two reviewers extracted data and conducted quality assessments using the mixed methods appraisal tool. Narrative synthesis was used to analyse findings.

Results Thirty-one studies were included, with the majority being UK based; most investigated nurse-led digital triage (n=26). Eight evaluated the impact on wider healthcare service use following digital triage implementation, typically reporting reduction or no change in service use. Six investigated patient level service use, showing mixed findings relating to patients' adherence with triage advice. Evaluation of clinical outcomes was limited. Four studies reported on hospitalisation rates of digitally triaged patients and highlighted potential triage errors where patients appeared to have not been given sufficiently high urgency advice. Overall, service users reported high levels of satisfaction, in studies of both clinician and non-clinician led digital triage, but with some dissatisfaction over the relevance and number of triage questions.

Conclusions Further research is needed into patient level service use, including patients' adherence with triage advice and how this influences subsequent use of services. Further evaluation of clinical outcomes using larger datasets and comparison of different digital triage systems is needed to explore consistency and safety. The safety and effectiveness of non-clinician led digital triage also needs evaluation. Such evidence should contribute to improvement of digital triage tools and service delivery.

PROSPERO registration number CRD42020178500.

Strengths and limitations of this study

- ► This is the first systematic review to focus on the use of telephone based digital triage in urgent care.
- ► This comprehensive, mixed-methods review covers a 20-year period, enabling evaluation of older literature prior to shifts of some services to non-clinician led models of service delivery.
- ► Outcomes relating to cost-effectiveness, and staff focused outcomes were not within the review scope.
- ► The review was limited to studies published in English, which may have led to some evidence being overlooked.

BACKGROUND

Telephone based digital triage is widely used in urgent care.[1 2] Urgent care is the 'the range of responses that health and care services provide to people who require—or who perceive the need for—urgent advice, treatment or diagnosis',[3] and includes national or regional help-lines, out of hours centres and emergency care providers.

Digital triage involves a call handler or clinician using a digital triage tool to generate advice based on an assessment of a patient's symptoms. Advice typically takes 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; in some cases self-care advice is given.

Digital triage service delivery models vary widely. In England and Scotland digital triage is delivered by non-clinical call handlers, for example, through the 111 service, which operates 24/7, while in most other countries it is predominantly clinician (nurse) led.[4–9] In part, digital triage has been implemented in response to increasing demand on primary care and EDs in the last several decades.[10]

Despite wide adoption over the last several decades, there is limited evaluation of its impact on wider healthcare service use, clinical outcomes and user experience. No previous systematic reviews have focused solely on services that use digital triage; instead reviewing telephone consultation and triage more broadly, including services that use digital triage and those that are not digitally supported.[1 10 11]

One review indicated that 50% of calls in the general healthcare setting (with studies predominantly conducted in primary care settings) could be handled completely over the telephone, showing the potential of telephone triage to manage face to face care demand.[10] However, there are mixed findings relating to wider healthcare service use and very limited investigation of clinical outcomes.[10] A previous review reported a high level of user satisfaction,[10] while another highlighted that satisfaction with advice related to improved compliance with advice.[11]

Given technological development and, in some cases, the reorganisation of services in recent years,[2] systematic reviews conducted several years ago (between 2005 and 2012)[1 10–13] may have limited relevance to today's services.

This review addresses the need for an up-to date evaluation of telephone-based digital triage within urgent care. It aims to evaluate wider healthcare service use, clinical outcomes and user experience in a range of in hours and out of hours urgent care settings in order to identify areas for improvement and the need for further research.

METHOD

This review uses a mixed-methods design and is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework.[14] See online supplemental appendix 1 for the PRISMA checklist.[15]

Patient and public involvement

No patient and public involvement (PPI) directly fed into the development or conduct of this review.

Eligibility criteria

Eligibility criteria have been developed using the population, interventions, comparators, outcomes and study designs principle[16]:

1. Population: studies that evaluated digital triage in the general population or within population subgroups (eg, older people).
2. Interventions: studies that assessed telephone based digital triage, which met all of the below criteria:
   1. In services providing urgent care (excluding in-hours GP)
   2. That was used by the general population (not condition specific services).
   3. That result in signposting advice (referral to a local service, such as ED, GP, ambulance dispatch and in some cases self-care advice).
3. Outcomes: studies that evaluated at least one of the following: characteristics of service users and triage advice; healthcare service use following triage; clinical outcomes (including hospitalisations and mortality) and service user experience.

All empirical study types published between 1 March 2000 and 1 April 2020 in English were included: qualitative, quantitative and mixed-methods studies.

Search strategy

The search strategy was designed with support from a librarian. Searches were conducted in Medline, Embase, CINAHL, Web of Science and Scopus. Terms relating to digital triage and urgent care settings (excluding in-hours GP) were used. See Medline search terms in online supplemental appendix 2. The search was restricted to studies published in English, including electronically published (Epub) studies ahead of print. Reference handsearches were conducted for all included full texts.

Study selection and data extraction

Articles were deduplicated ahead of study selection. Two reviewers screened studies independently at title and abstract stage and at full text stage using Covidence software. Any disagreements were resolved through discussion between the reviewers; where necessary a third reviewer was consulted. A PRISMA flow chart was is presented in the results.

A data extraction form was developed and initially piloted on three studies to confirm that key elements of studies were captured. See online supplemental appendix 3 for data extraction fields. Data were extracted independently by two reviewers, and any discrepancies were resolved through discussion with a third reviewer. Study authors were contacted in cases where clarifications regarding study conduct were required.

Quality assessment

Quality assessment, including risk of bias, was conducted by two reviewers using the mixed methods appraisal tool (MMAT),[17] which enables the assessment of mixed study types. The assessment was used to provide context, rather than to exclude studies.[18] Based on the number of MMAT criteria met, studies were categorised as high (if all five MMAT criteria were met), medium (if three or four criteria were met) or low quality (if two or less criteria were met).

Data synthesis

Narrative synthesis[18] was used due to the diversity of designs in the included studies. This included: generating a preliminary synthesis, exploring relationships in findings across studies, assessing the robustness of the evidence and summarising findings.[18] Statistical meta-analysis was not possible due to the heterogeneity of the included studies. Key findings within and between studies were grouped by outcome and visually summarised using a subgroup analyses method,[18] which we modified to additionally present the strength of evidence. Where a

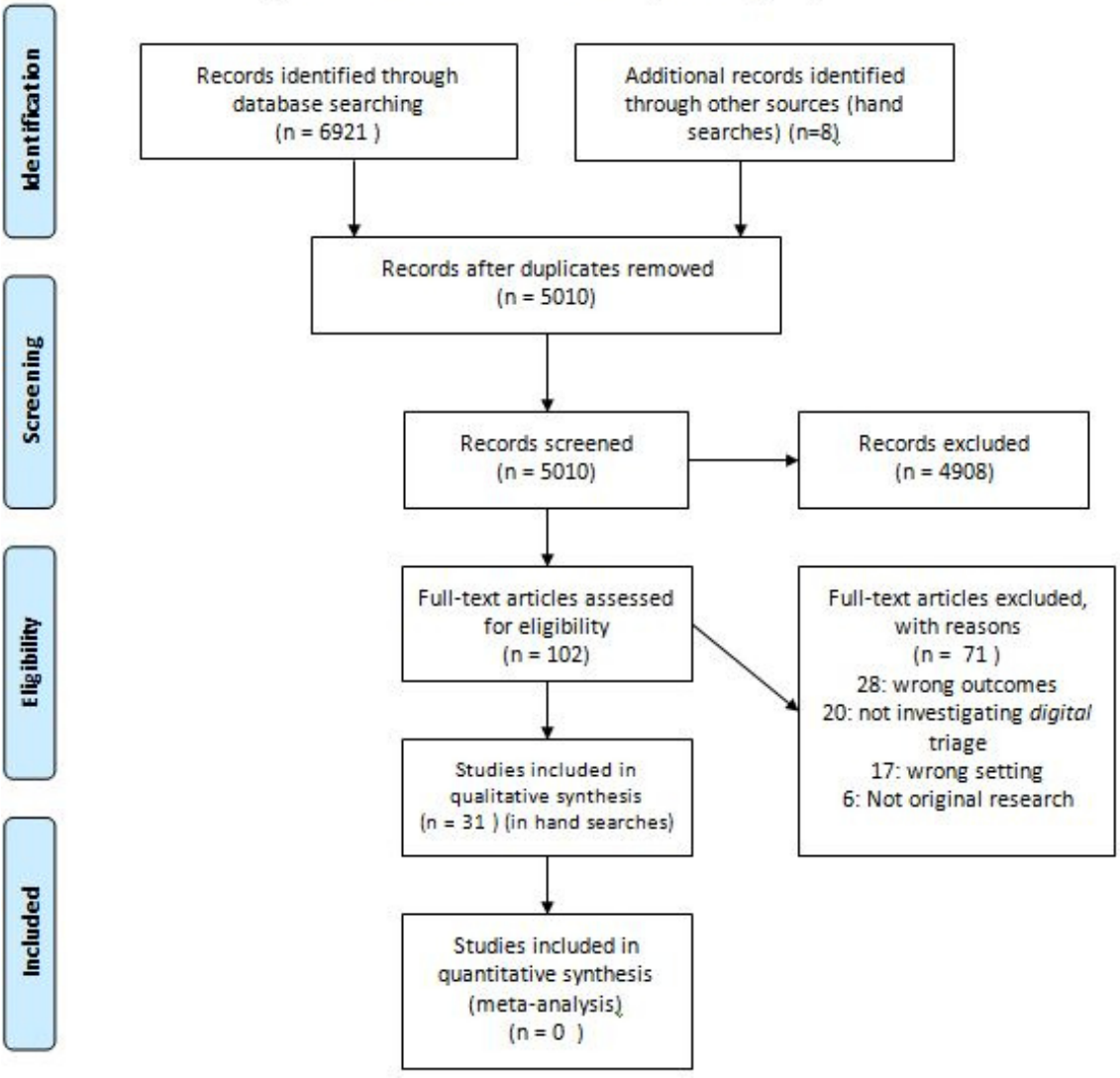

Figure 1 PRISMA flow chart. PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

visual summary was not possible due to heterogeneity of outcomes, findings were summarised in text.

RESULTS

The search resulted in 6921 records, after duplicates were removed, there were 5010 records to screen at title and abstract level; 102 records were included for full-text screening, out of which 31 studies were included. See figure 1 for PRISMA flow chart.

Most included studies were of quantitative design (n=25)[5 7 19–41] including: routine data analyses(n=16),[5 7 19–25 27 29 34 35 37–39] surveys(n=6),[26 28 31 33 40 41] controlled trials (n=2)[30 36] and a quantitative descriptive study (n=1).[32] There were fewer qualitative (n=4)[42–45] and mixed-methods studies (n=2).[6 46]

Studies were mainly from the UK (n=17),[5 6 20 21 23 26–29 32 36–38 40 42 43 46] with small numbers from Sweden (n=4),[41 44 45 47] Australia (n=4),[30 31 34 39] USA (n=3),[7 19 22] Netherlands (n=2),[25 33] Japan (n=1)[35] and Portugal (n=1).[24] Most included the full range of service users (n=24),[5 6 19 21–26 28 30 32–36 38–41 43–46] but some focused on subsets: older adults,[21 24] younger age groups,[20 37] parents of children,[31] men[42] or adults with limited English proficiency (LEP).[7]

Most studies evaluated digital triage conducted by nurses (n=26),[5 7 19–34 37 39 41–46] but some included non-clinicians (n=3),[6 38 40] nurses and paramedics (n=1)[36] or nurses and non-clinical call handler (n=1).[35]

Most studies were of identifiable call centre-based services: England's former National Health Service (NHS) Direct[20 21 23 26 28 29 37 42–44 46] and current NHS 111 service,[38 40] Scotland's NHS24,[5 6] USA's MayoClinic,[7 19 22] Portugal's Linha Saude 24,[24] Swedish Health Direct,[41 44 45] Australia's Health Direct.[34] A few involved smaller scale 'unnamed' implementations[30 39] or GP cooperatives.[25 32 33] Two were based in the emergency setting, one within an English ambulance service[36] and one within an emergency telephone service in Japan.[35] Table 1 shows characteristics of studies.

Table 1 Characteristics of included studies (31 studies)

Main outcome area	Author year Country Reference	Study design	Sample/data size	Urgent or emergency care	Staff type conducting triage	Participants and service name	Comparator	Quality
User experience	Björkman 2018 Sweden[44]	Qualitative: 'Netnographic' method using information from online forums using six step	Data collected from 3 online forums	Urgent	Nurse	General population	None	High
User experience	O'Cathain 2014 England[40]	Quantitative: Survey	Survey sent to 1200 patients from 4 pilot sites, 1769 responded and were included for analysis	Urgent	Non-clinical call handler	General population	None	Medium
User experience	McAteer 2016 Scotland[6]	Mixed methods: survey and interviews	Survey: Age and sex-stratified random sample of 256 adults from each of 14 Scottish GP surgeries, final sample was 1190. Interviews: 30 semistructured interviews	Urgent	Non-clinical call handler	General population (National Health Service (NHS) 24 users and non-users)	Interviewees (from survey respondents) grouped into satisfied users, dissatisfied users and non-users	High
User experience	Rahmqvist 2011 Sweden[41]	Quantitative: Survey	Random sample of 660 callers, made at one call centre site in October 2008	Urgent	Nurse	General population	(1) Cases: those who disagreed with nurse advice and felt they needed higher level of care; (2) Controls: those who disagreed with nurse advice OR felt they needed higher level of care; (3) other callers	Medium
User experience	Goode 2004 England[43]	Qualitative: Interview study	60 interviews	Urgent	Nurse	General population	None	High
User experience	Winneby 2014 Sweden[45]	Qualitative: Interview study	8 semistructured interviews	Urgent	Nurse	General population	None	High
User experience	Goode 2004 England[42]	Qualitative: Interview study	10 semistructured interviews	Urgent	Nurse	Interviews focused on men	None	High

Continued

Table 1 Continued

Main outcome area	Author year Country Reference	Study design	Sample/data size	Urgent or emergency care	Staff type conducting triage	Participants and service name	Comparator	Quality
Patterns of triage advice	Payne 2001 England[23]	Routine data analysis	56 450 calls	Urgent	Nurse	General population	None—comparisons within digital triage call data	High
Patterns of triage advice	Elliot 2015 Scotland[5]	Routine data analysis	1 285 038 calls	Urgent	Nurse	General population	None—comparisons within digital triage call data	High
Patterns of triage advice	Zwaanswijk 2015 Netherlands[25]	Routine data analysis	895 253 patients	Urgent	Nurse (GP cooperative)	General population	Some comparison with non-digital triage	High
Patterns of triage advice	Njeru 2017 USA[7]	Routine data analysis	587 cases 587 controls	Urgent	Nurse	Those aged over 18— (callers with and without limited English proficiency)	Patients with limited English proficiency compared with English proficient	High
Patterns of triage advice	Jacome 2018 Portugal[24]	Routine data analysis	148 099 calls	Urgent	Nurse	General population (Older age groups 65+)	None - Comparisons within digital triage call data	High
Patterns of triage advice	Hsu 2011 England[21]	Routine data analysis	402 959 calls	Urgent	Nurse	Older age groups (aged over 65 years)	None	High
Patterns of triage advice	Cook 2013 England[20]	Routine data analysis	358 503 calls	Urgent	Nurse	children aged 0–15 (<1, 1–3 and 4–15 years))	Comparisons between age groups	Medium
Patterns of triage advice	North 2010 USA[22]	Routine data analysis	20 230 calls	Urgent	Nurse	General population (those with subscription and insurance)	Three comparison groups: (1)Triaged callers; (2) Emergency Department (ED) attendances; (3) Office (GP) visits. (Comparison of hospitalisation in these groups)	Medium
Patterns of triage advice	North 2011 USA[19]	Routine data analysis	Over the 3-year period: 105 866 adult calls (65% of the total calls). Of these, 14 646 (14%) were made by a surrogate on behalf of the patient.	Urgent	Nurse	General population (aged over 18)	Surrogate vs self calls	Medium

Continued

Table 1 Continued

Main outcome area	Author year Country Reference	Study design	Sample/data size	Urgent or emergency care	Staff type conducting triage	Participants and service name	Comparator	Quality
Service use following triage	Lattimer 2000 England[32]	Quantitative descriptive: Cost-effectiveness report from controlled trial	>14 000 Control group (n=7308 calls) Intervention group that is, Nurse telephone consultation (n=7184 calls)	Urgent	Nurse (within general practice cooperative)	General population	Usual care (referral to a General Practice) compared with nurse-led digital triage	Medium
Service use following triage	Munro 2000 England[29]	Routine data analysis	Study corresponds to the 1st year of operation, where 68 500 NHS direct calls from the 1.3 million people served.	Urgent	Nurse	All contacts with these immediate care services (at time spanning before and after introduction of call centre based service)	Service use in regions where digital triage service was introduced, compared with regions with no implementation	High
Service use following triage	Dale 2003 England[36]	Controlled trial	635 triaged calls 611 non-triaged calls	Emergency	Nurse and paramedic (within emergency control room)	General population, calling the emergency service for non-emergency concerns (only those aged 2+)	The control group not offered triage was compared with calls digitally triaged either by nurses or paramedics.	High
Service use following triage	Foster 2003 England[27]	Routine data analysis and data linkage	4493 calls, of which 193 were advised to go to Emergency Department (ED)	Urgent	Nurse	General population	Three comparison groups: 1. Callers triaged to Emergency Department (ED), who attended 2. Callers triaged to ED who did not attend 3. Callers with different triage outcome who attended ED.	Medium
Service use following triage	Mark 2003 England[46]	Mixed methods (routine data analysis +interviews)	Numbers of calls analysed across 3 years: 5126 (year 1998) 5702 (1999) 4698 (2000)	Urgent	Nurse	General population	n/a	Low

Continued

Table 1 Continued

Main outcome area	Author year Country Reference	Study design	Sample/data size	Urgent or emergency care	Staff type conducting triage	Participants and service name	Comparator	Quality
Service use following triage	Sprivulis 2004 Australia[34]	Routine data analysis & data linkage	13 019 presentations to Emergency Department (ED) of which 842 were identified as having contacted Health-Direct within the 24 hours period prior to presentation.	Urgent	Nurse	General population—all patients who contacted the digital triage service during the 1-year study period	1. Patients who were digitally triaged prior to attending ED 2. Patients who were not digitally triaged	High
Service use following triage	Dunt 2005 Australia[30]	Quantitative: four trials including surveys (self-reported service use)	Random sampling (350 households per trial site)	Urgent	Nurse	General population	2 sites using 'standalone' telephone triage which used 'call centre software' 2 embedded telephone triage sites using paper based protocols	Medium
Service use following triage	Munro 2005 England[28]	Quantitative: Surveys (care providers)	571 surveys sent (188/297) responses from GP cooperatives, (35/35) for ambulance services and (200/239) for emergency departments	Urgent	Nurse	Surveys sent to care providers (general use of services following NHS direct implementations)	n/a	Medium
Service use following triage	Stewart 2006 England[37]	Routine data analysis & data linkage	3312 calls to call centre based service, and 14 029 patients who attended Emergency Department (ED)	Urgent	Nurse	Children and young adults aged under 16	1. Patients advised through digital triage to attend ED 2. Patients given alternative referral advice, through digital triage, but who still attended ED 3. Patients referred to ED by their GP 4. Self-referrals to ED	High

Continued

Table 1 Continued

Main outcome area	Author year Country Reference	Study design	Sample/data size	Urgent or emergency care	Staff type conducting triage	Participants and service name	Comparator	Quality
Service use following triage	Byrne 2007 England[26]	Quantitative: Survey	268 callers	Urgent	Nurse	General public with 3 symptom types (abdominal pain or cough and/or sore throat)	None	High
Service use following triage	Morimura 2010 Japan[35]	Routine data analysis	26 138 telephone consultations	Emergency	Nurse and call handler	General population	None	Medium
Service use following triage	Huibers 2013 Netherlands[33]	Quantitative: Questionnaires	7039 questionnaires returned (from a total of 13 953 sent)	Urgent	Nurse	General population (users who had a telephone contact with a nurse)	None	High
Service use following triage	Turner 2013 England[38]	Routine data analysis	400 000 calls to call centre based service in first year of operation analysed	Urgent	Nurse	General population	Matched sites: (1) Intervention sites: four digital pilot sites; (2)Control sites (North of Tyne, Leicester, Norfolk)	High
Service use following triage	Turbitt 2015 Australia[31]	Quantitative: Surveys	1150 parents attending Emergency Department (ED) (decline rate 19.9%)	Urgent	Nurse	Specific group	Some comparisons between parents who called and did not call but prior to attending ED	Medium
Service use following triage	Siddiqui 2019 Australia[39]	Routine data analysis and data linkage	12 741 triaged cases linked to 72.577 ED presentations	Urgent	Nurse	General population	None	High

ED, emergency department; GP, general practice.

Nineteen studies were rated as being of high quality,[5–7 12 23–26 29 33 34 36–39 42–45] 11 medium[19 20 22 27 28 30–32 35 40 41] and 1 was low.[46] Qualitative studies tended to be of higher quality, while quantitative studies were more variable. Reasons for lower quality among quantitative studies included inadequate description of accounting for confounders[28 30 34 35] and risk of non-response bias.[31 32 40 41] One mixed-methods study did not adequately describe integration of qualitative and quantitative components.[46] In two of the qualitative studies details about how the findings were derived from the data could have been expanded.[43 45] The quality assessment results are included in online supplemental appendix 4.

Patterns of use

Nine studies focused on patterns of triage advice; all used routine datasets.[5 7 19–25] Key findings are summarised below; detailed findings from studies are in online supplemental table 1.

Characteristics of patients and callers

Presenting symptoms with highest frequency among patients, included: abdominal or digestive problems, 6.8%–12.2% of calls[5 19 22 24 39] and respiratory problems, 11.3%–11.9%[39 24] of calls. The majority of calls were made by women (range: 59%–72%).[5 19 22–24 39]

Calls about patients in younger age groups[22 23] made up a comparatively high proportions of calls; 24% of calls were for 0–5 years in one study[23] and another reported 15% of out of hours calls being for 0–4 years.[5]

User characteristics and triage advice urgency

Factors associated with triage advice urgency included:

1. Patient's age: Two studies reported urgency to be lower in children and younger age groups[23 20], one study reported a high proportion (47%) of calls about children aged (0–15) were resolved through self-care advice or health information.[20] Two studies reported that urgency increased with age.[19 24]
2. Sex: Two studies reported women were more likely to receive lower urgency advice as compared with men; however, neither controlled for age or presenting symptoms,[21 23] one suggested this may be explained by women seeking care advice earlier, before their symptoms progress and become more urgent.[21]
3. Symptoms: Two studies reported symptoms associated with higher urgency advice[20 25]; for example, calls about children with respiratory problems were more likely to be referred to emergency care as compared with other symptom types.[20]
4. Caller language proficiency: One case–control study reported that adults with LEP were more likely to receive higher urgency advice (ambulance, immediate ED attendance or urgent visit) (49.4% vs 39.0%; p<0.0004)[7]; groups in this study were balanced based on age and sex and comorbidities were controlled for.[7]

Service use and clinical outcomes following triage

Change in service use following digital triage implementation

Eight studies reported on change in wider healthcare service use (primary care, ED use, ambulance use and emergency admissions) following implementation of digital triage.[28–30 32 35 36 38 46] Of these, one investigated non-clinician led triage.[38] Comparators included: rates of service use in patients receiving usual care (eg, GP referral) in comparison to those who were digitally triaged[32 36]; service use rates prior to implementation[28 30 35 46]; comparator regions with no digital triage implementation[29 38] and national service use comparator.[30]

There were mixed findings across studies, as visually summarised in figure 2. Most reported reduction or no change in wider service use after implementation; there were two exceptions, which both evaluated clinician (nurse) led digital triage: one (rated as being a lower quality study) reported an increase in ED use.[46] The other reported some increase in out of hours service use (GP clinic use and home visits) related to 'standalone' digital triage call centres in comparison to national comparator; however, this study differed to the other studies as it utilised household surveys to capture service use.[30]

Online supplemental table 2 presents detailed findings from studies.

Patient level service use and adherence with advice

Six studies reported varying patient adherence to triage advice through evaluation of patients' subsequent ED attendance.[26 27 31 34 37 39] Four used routine data and data linkage with sample sizes ranging from: 3312 to 13 019 triage calls. Of these, three studies reported 60%–70%

Author/year/reference	Reduction in primary care workload *	No significant change in primary care use *	Increase in primary care workload *	No signifiant change in ED attendance	Increase in ED attendance	Reduction in emergency admissions	Reduction in ambulance service workload	No signifiant change in use of ambulance services
Lattimer 2000 (32)	✓					✓		
Munro 2000 27 (29)	✓			✓				✓
Dale 2003 (36)							✓	
Mark 2003 (46)	✓				✓			
Dunt 2005 (30)			✓					✓
Munro 2005 (28)	✓			✓				✓
Morimura 2010 (35)							✓	
Turner 2013 (38)		✓		✓			✓	

*change in one or more: home visits, general practice cooperatives, primary care centres or OOH general practice
Green = studies of high quality
Amber = studies of medium quality
Red = studies of lower quality

Figure 2 Findings from studies of out of hours (OOH) service use after digital triage implementation. ED, emergency department.

of patients who were advised to attend ED followed this advice[27 34 37] ; one reported a range of 29%–69%, with higher compliance when ambulance was advised (53%–69%) and lowest compliance when self-transport to ED was recommended (29%).[37]

One small survey of 268 callers reported high levels of adherence with advice to attend ED (96%; 49 of 51 calls), to contact a GP (92%; 133 of 144) and to self care (93%; 64 of 69).[26]

Four studies reported proportions of patients who attended ED after receiving alternative triage advice (other than attending ED): 2.4%,[27] 9%[34 37] and 22%.[31] The latter included 51 of 1150 parents who had remained worried after calling the digital triage service.[31] Results are showed in online supplemental table 3.

Safety

Four studies highlighted potential triage errors based on hospital admission rates.[27 34 36 37] These mainly related to potential 'undertriage', where the advice was considered to be at too low a level of urgency in relation to clinical need. However, these findings were peripheral to the main aims of these studies.[27 34 36 37]

One study reported similar hospitalisation rates between patients attending ED who had been directed to 'immediate or prompt' care and 'non-urgent' care: immediate or prompt: 38%(n=261), 95% CI 34 to 41 vs non-urgent: 37% (n=56), 95% CI 30 to 44).[34] Another reported 15% (n=71) of paediatric cases attending ED after being triaged were admitted; of these, 37 had been advised to attend ED and 34 were given other lower urgency advice.[37]

Another study reported 15% (n=15) of patients given advice that was lower urgency than ED attendance, (such as urgent or routine GP appointment or self care), attended ED following their triage call and were admitted.[27] One study reported 9.2% (n=30) of patients triaged as not requiring ambulance dispatch were subsequently admitted.[27 36]

One qualitative study described users reporting not having received appropriate triage advice for symptoms which later turned out to be more serious.[44]

Service user experience

Seven studies focused on user experience and satisfaction.[6 40–45] Three studies reported a high level of satisfaction among users.[6 31 40] Two studies reported higher satisfaction among those who received higher urgency advice.[40 41] Two studies reported dissatisfaction relating to the relevance and number of triage questions.[6 40]Three studies highlighted that callers felt they needed to be assertive in order to receive the expected care advice.[42 44 45] For example, a user's post to an online forum:

> If you need help and advice you can always call the healthcare advice line, if you think they're giving you the 'wrong' advice, tell them, and maybe you'll get better help.[44]

Two studies reported that users felt that the nurses using digital triage gave them time, conducted 'thorough' assessments and felt reassured.[43 45]

In contrast, one study of users who posted to an online forum reported feeling scrutinised by the nurses questioning their symptoms and need for care.[44] Some expressed doubts about nurses' advice, competency and credibility.[44]

Integrated services made for a smoother patient care journey. One study based on an online forum described the experience of poor integration:

> They send you to the ER where they yell at you for being stupid enough to listen to them (SHD). SHD is a big problem and seems to be at war with the ER.[44]

In contrast, there was high satisfaction in 71%, of users where the service provider was able to book an appointment at a local service on behalf of the patient.[40]

See figure 3 for a visual summary of findings across studies and table 2 for detailed findings.

DISCUSSION

This systematic review has evaluated the evidence on how telephone-based digital triage affects wider healthcare service use, clinical outcomes and user experience in urgent care. Thirty-one studies were included, covering a range of different designs, settings, populations and digital triage systems. Studies typically showed no change

Author/year/reference	Positive experiences / high level of satisfaction	Satisfaction related to advice urgency (higher urgency advice related to greater satisfaction)	Use of assertiveness to influence triage advice	Users felt reassured	Doubts about call takers' competency	Safety concerns	Length & relevance of triage questions
Bjorkman 2018 (44)	✓		✓		✓	✓	
O'Cathain 2014 (40)	✓	✓					✓
McAteer 2016 (6)	✓						✓
Rahmqvist 2011 (41)		✓					
Goode 2004 (43)	✓			✓			
Winneby 2014 (45)	✓		✓	✓			
Goode 2004 (42)	✓		✓	✓			

Green = studies of high quality

Amber = studies of medium quality

Figure 3 Key themes from studies of user experience.

Table 2 Findings from studies that investigated user experience and satisfaction

Author year Country Reference	Study type	Sample/data size	Digital triage user	Participants	Key themes and example quotes
Björkman 2018 Sweden[44]	Descriptive research design using information from online forums using six step 'netnographic' method	Data from 3 Swedish online forums were purposively sampled.	Nurse	General population (users)	General satisfaction/attitudes *'Where we are, the healthcare advice line is great, I'd rather call them than my primary care center'* Experience of call taker: Patients expressed doubts and mistrust on advice given and credibility of nurses. Feelings that nurses were not well competent/ qualified and relied on google: '*And seriously, are they real nurses who take the calls at SHD? I almost think it sounds like they're googling every question they get.'* **Safety***:* Some concerns related to safety and feeling that advice given was not appropriate, for example: a user posted that they were advised to stay at home for a condition that turned out to be serious, '*When you're advised to take two paracetamols and go to bed. Not go into the ER. When I was feeling really bad, and called them and described my symptoms, that's the exact advice I was given. The situation ended with my husband more or less forcing me into the car and driving me to the hospital. By then, my lips were purple and I was having trouble keeping my balance. Once there, they found that both my lungs were filled with 100 s of small blood clots.'* Assertiveness and negotiation*: One user posted, 'If you need help and advice you can always call the healthcare advice line, if you think they're giving you the 'wrong' advice, tell them, and maybe you'll get better help'* Service working together: a user expressed dissatisfaction where the service did not work well together, *'There's no point calling [digital triage service name]. They send you to the ER where they yell at you for being stupid enough to listen to them. [digital triage service name] is a big problem and seems to be at war with the ER'*

Continued

Table 2 Continued

Author year Country Reference	Study type	Sample/data size	Digital triage user	Participants	Key themes and example quotes
O'Cathain 2014 England[40]	Survey	Survey sent to 1200 patients from each of the 4 pilot sites studied, 1769 responded and were included for analysis	Non-clinical call handler	General population (users)	General satisfaction/attitudes Satisfaction levels were good overall (91% very satisfied or satisfied). 73% (1255/1726, 95%CI: 71% to 75%) were very satisfied with the way NHS 111 handled the whole process, 19% (319/1726) were fairly satisfied and 5% (79/1726) were dissatisfied. Two aspects of the service were less acceptable than others: 1) relevance of questions asked and 2) whether the advice given worked in practice. Greater satisfaction with higher urgency advice: Patients more likely to feel the service was helpful if directed to ambulance service (76%), compared with self-care(64%) visit health centre (55%), other service 54%, contact GP (52%). Services working together: Patients more likely to feel the service was helpful if an appointment was arranged for them (71%).
McAteer 2016 Scotland[6]	Other—mixed methods	Age-stratified and sex-stratified random sample of 256 adults from each of 14 Scottish GP surgeries, final sample was 1190 based on response rate with 601 of those having used the digital triage service. Purposive sampling used for interview group with total of 30 being interviewed.	Non-clinical call handler	General public (users and non-users)	General satisfaction/attitudes: ► Questionnaire findings: over 80% of those who had used the digital triage service reported being either 'satisfied' or 'very satisfied' - education was the only socioeconomic factor associated with satisfaction (with higher educated participants being less satisfied). Interview findings showed users were broadly satisfied with service. ► Most common reasons for dissatisfaction related to initial triage questions, for example, '*I just felt that, she should get me onto a nurse and stop asking me questions, you know, I felt it went on too long*', and the length of time it took to receive visits and not being kept informed.

Continued

Table 2 Continued

Author year Country Reference	Study type	Sample/data size	Digital triage user	Participants	Key themes and example quotes
Rahmqvist 2011 Sweden[41]	Survey	Random sample of 660 callers, made at one site in October 2008	Nurse	General public (users)	Greater satisfaction with higher urgency advice Patients who were recommended to wait and see, were less likely to be satisfied and more likely to make an emergency visit or an on call doctor. Results reported in relation to callers' agreement with advice: analysed using 3 groups: (1) cases: those who disagreed with nurse advice *and* felt they needed higher level of care; (2) controls: those who disagreed with nurse advice or felt they needed higher level of care; (3) other callers. Average global patient satisfaction was significantly lower for nurses who served the cases compared with those who had not served the cases
Goode 2004 England[43]	Interview study	60 interviews	Nurse	General public (users)	General satisfaction/attitudes Results related to feelings that the digital triage service was 'trustworthy', and being able to access care without being a 'nuisance'. Authors state that some interviewees experienced or predicted deterioration in service quality: 'They'll put a bit too much work on their call centres, they'll be understaffed, then they'll start becoming hurried or you'll lose that friendly 'take as long as you like' sort of attitude that I experienced…' Experience of call taker: reassurance Users felt reassured and cared for: ► 'I felt like they cared. I was suffering and I felt like they cared. And that's what I wanted' ► 'For me to be able to ring somebody, you know, and when I did feel in pain, but wasn't sure whether it was normal or not—well I knew that it wasn't normal, but is it common? And it was nice just to speak to somebody. And, 'Okay, yeah, do go to your doctors', you know, 'you're not being silly'

Continued

Table 2 Continued

Author year Country Reference	Study type	Sample/data size	Digital triage user	Participants	Key themes and example quotes
Winneby 2014 Sweden[45]	Interview study	8 semistructured interviews	Nurse	General public (users)	Experience of call taker: feeling reassured when taken seriously The authors describe findings relating to users feeling reassured on follow-up care required, '*When the nurse believed and advised them to turn to the care center on duty, having obtained a mandate to go there, gave them a sense of security*'. A quote from a participant: '*Because they [nurses] know more than I do and will refer me if it's something serious.'* Assertiveness and negotiation *'Being a nurse, I know what to say and what I've done at home. Otherwise they will tell you to 'drink plenty of fluids' and 'do this and that'. But now I say that 'I have drunk a lot" and 'I have medication at home'. It feels as if they [SHD] try to sift out and turn away… you don't call unless it's necessary.'*
Goode 2004 England[42]	Interview study	10 interviews	Nurse	**General public (users) interviews with men/or that related to men**	General satisfaction/attitude**s** ► **A** participant commented on male partner: 'He thought it was great. He was very impressed. And a male nurse spoke to him as well, which I think he was even more impressed that a man would know what he was talking about**…'** ► **T**he authors describe a male interviewee whose wife called on his behalf 'He now described NHS Direct as an excellent and much-needed service, which he would continue to use to meet his need for **'**expert**'** guidance on the appropriate response to symptoms.**'** Assertiveness and negotiation One male participant made a follow up call to NHSDirect regarding his wife**, while** his wife was waiting for a call back from the service: 'I simply had one aim at that point, which was to get a doctor out to the house without putting the phone down**…** everything was pretty much arranged in the one call. It was acknowledged that things were bad and that a doctor would be calling tonight**…** I guess I was being pretty direct, like, 'She is sick and she must be seen.**'**

GP, general practice.

or a reduction in wider healthcare service use following the implementation of digital triage. They reported varied levels of caller adherence to the triage advice provided. There was very limited evidence on clinical outcomes; however four studies reported some findings on hospitalisation rates that highlighted potential safety concerns relating to under-triage.

Overall user satisfaction with telephone based digital triage appears to be high, but there was some evidence of poorer user experience relating to the length and relevance of triage questioning, and perceptions of 'under-triage'. Users sometimes felt the need for assertiveness during calls when their expectations were not being met; however, this is unlikely to be specific to digital triage and has been reported in telephone-based consultation more widely.[48]

There was considerable heterogeneity across studies in terms of types of setting, types of participants, study designs and 'digital triage' systems. 'Digital triage' is a complex intervention with outcomes that may be influenced by multiple factors due to varying healthcare systems, local service configuration, staff training and an evolving landscape in the use of digital technologies to allow patients to seek urgent care, for example, through the use of digital self-triage tools. Hence, there needs to be caution in the interpretation of the applicability of findings. Additionally, strength of evidence differed between studies, as demonstrated by the visual tables of key findings; these differences fed into the narrative synthesis of this review.

Many of the studies that investigated service use following digital triage implementation reported no change in wider healthcare service use. In one context, for example, following the replacement of a nurse-led service with a non-clinician led service this may be seen as a success,[38] but this may not be applicable to all healthcare settings. One study of 'standalone' digital triage implementation showed an increase in GP clinic use,[30] which was in contrast to other studies in this review; this may be because this service was less embedded within the healthcare system, but could also have been a methodological consequence of using household surveys to gather service use data.[30]

Strengths and limitations

This is the first systematic review to focus on the use of telephone based digital triage in urgent care. It covered a 20-year period, during which some services have started to shift towards non-clinician-led models of service delivery. This review enabled evaluation of a broad range of service models and settings. However, it was limited to studies published in English, and this may have led to important evidence being overlooked.

This review used a comprehensive mixed-methods approach and evaluated quality of studies using the MMAT tool. While this tool worked well for many studies in this review, an acknowledged limitation[49] is the applicability of its criteria for assessing studies that are cross-sectional in nature (where there are not necessarily defined groups with an intervention or exposure); this is applicable to some of the studies included in this review

There was limited evaluation of non-clinician led models of digital triage, with only one study evaluating service use following implementation and no studies of clinical outcomes. Another limitation is the scope of the included outcomes; outcomes relating to broad utilisation of services that use digital triage (such as call volumes, call lengths and caller characteristics alone), cost-effectiveness and staff focused outcomes were not covered.

While PPI did not directly feed into this review, this forms the first stage of a wider project investigating user outcomes related to digital triage. For the wider project, has been sought in the project design, and a panel has been selected to aid the interpretation of results and dissemination of findings.

Comparison with other literature

This review's focus is narrower, in terms of intervention and setting, compared with previous reviews which evaluated telephone triage more broadly, including services that were not digitally supported.[1 10] Bunn *et al*'s review evaluated telephone triage in comparison to usual care.[10] They similarly reported no significant change in wider healthcare use (ED visits, routine GP visits and hospitalisations) associated with telephone triage. Other reviews found that user satisfaction is generally high when comparing telephone consultation with other forms of care,[10] but lower satisfaction was described when patients' initial expectations were not met.[48]

Our review highlights the limited evaluation of clinical outcomes. A previous review of telephone triage reported limited and inconclusive findings on mortality rates (with no mortalities occurring in some studies that sought to investigate this outcome), and rates of undertriage and subsequent hospitalisation ranging from 0.2% to 5.25%.[1]

Although our review did not include broad utilisation outcomes related to digital triage, a previous study reported lower than expected use by some ethnic minority groups.[50] Our review found that no studies to date have reported on patterns of advice, user experience, service use or clinical outcomes in ethnic minority groups; this may have been limited by our exclusion of studies that were not published in English.

We found that patients' adherence with advice varied by setting and study design. While very high adherence was reported in one survey based study,[26] this may be an overestimate due to response bias in comparison to other studies that evaluated adherence based on routine data. Similar observations in higher adherence rates in self-reported service use were reported by two reviews.[11 13]

Implications for service delivery and future research

The review has identified several gaps in the literature, particularly a need for evaluation of patient level service use and clinical outcomes. Further analysis of large

patient level datasets (particularly those that are linked with subsequent service use and clinical outcomes data) will help to gain a better understanding of who does and does not adhere to advice and help to evaluate safety concerns relating to under triage within particular patient subgroups.

In the absence of comparative studies, it is unclear how patient satisfaction and outcomes are affected by the design of services, the staff groups involved and how they are trained and managed, and the type of digital triage system deployed. Further evaluation of non-clinician led digital triage may help policy-makers and service commissioners to adopt the most efficient and safe digital triage systems.

While not a key aim, this review highlights that associations between factors (such as age, gender, ethnicity) and urgency of advice have not been explored in depth. The granular demographic and symptom data captured by digital triage tools gives opportunity to explore these associations which will likely provide insight into how services are used by different groups and form the basis for generating hypotheses within particular groups.

Many studies in this review were undertaken when digital triage was first being implemented. However, like any significant service change, digital triage services will take a significant period of time to become established and performing optimally within urgent care services that have been used to working in another way. To date, no studies have involved longitudinal data collection to evidence the extent to which this occurs. Longer-term evaluation studies are needed to explore how the safety and effectiveness of services changes over time. In addition, telephone-based approaches to seeking care have been critical during the COVID-19 pandemic and are likely to be more widely adopted in the long term[51]; therefore, evaluation of how these services have functioned during and after the pressures of a pandemic is also important.

Lastly, this review highlights limited qualitative and mixed-methods approaches to date. Integrating findings from routine data with qualitative research will help to better understand user experiences and care needs of particular patients groups in more depth. These could feed into targeted support for these groups within or outside of digital triage services, and ultimately improved delivery of these services which are key to a well functioning healthcare system.

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PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	2
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	4
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	5 (appendix 2)
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	6
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6 (appendix 3)
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	n/a

PRISMA 2009 Checklist

Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	7

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	n/a
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6 (+ appendix 3)
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	8 (table 1)
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	8 (table 1)
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	n/a
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	n/a
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8 (table 1) See MMAT rating
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	n/a
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	44 – 45
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	45
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	46 - 47
FUNDING			

PRISMA 2009 Checklist

Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	48

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(6): e1000097. doi:10.1371/journal.pmed1000097

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

Appendix 2: Search terms used for Medline search

Concept	Search terms
Care setting	Primary care.mp OR Primary Health Care/ OR After-Hours Care/ OR Out of hours.mp OR Emergency care.mp OR Emergency Medical Services/ OR Urgent care OR Ambulatory Care AND
Triage	Triage.mp OR Triage/ OR Telephone consultation.mp AND
Digital	Digital OR Computer OR Software OR Online OR Internet OR Web OR Computerised OR Computerized OR electronic OR ECDS* OR CCDS* OR Decision Support Systems, Clinical/ OR Decision support*

Appendix 3

Data extraction form variables

The following information was extracted and entered into the data extraction form:

- Author
- Publication year
- Country
- Study design
- Care setting
- Participants
- Intervention details
- Type of care service staff conducting triage (doctor/nurse/paramedic/non-clinician),
- Comparator
- Outcomes
- Effect of intervention
- Contextual factors, (for example: staff experience and training, time that the service has been in place, level of support available to call takers).

Appendix 4 MMAT results - studies investigating patterns of triage advice urgency

Quantitative Non-Randomised studies		Frederick North 2011	EJ Cook 2013	Wen-Chin Hsu 2010	F North 2010	Zwaanswijk 2015
Screening questions	Are there clear research questions?	Yes	Yes	Yes	Yes	Yes
	Do the collected data allow to address the research questions?	Yes	Yes	Yes	Yes	Yes
Criteria for **Quantitative (Non-randomised studies)**	Are the participants representative of the target population?	Yes	Yes	Yes	Yes	Yes
	Are measurements appropriate regarding both the outcome and intervention (or exposure)?	Yes	Yes	Yes	Yes	Yes
	Are there complete outcome data?	No	No	Yes	Can't tell	Yes
	Are the confounders accounted for in the design and analysis?	Can't tell	Can't tell	Can't tell	Can't tell	Can't tell
	During the study period, is the intervention administered (or exposure occurred) as intended?	Yes	Yes	Yes	Yes	Yes
		Medium (3/5)	**Medium (3/5)**	**High (4/5)**	**Medium (3/5)**	**High (4/5)**

Quantitative Descriptive studies		F Payne 2005	M Jacome 2018	A Elliot 2011	J Njeru 2017
Screening questions	Are there clear research questions?	yes	Yes	Yes	Yes
	Do the collected data allow to address the research questions?	yes	Yes	Yes	Yes
Criteria for **Quantitative (Descriptive studies)**	Is the sampling strategy relevant to address the research question?	yes	Yes	Yes	Yes
	Is the sample representative of the target population?	yes	Yes	Yes	Yes
	Are the measurements appropriate?	yes	Yes	Yes	Yes
	Is the risk of nonresponse bias low?	Yes	Yes	Yes	Yes
	Is the statistical analysis appropriate to answer the research question?	Yes	Yes	Yes	Yes
		High (5/5)	**High (5/5)**	**High (5/5)**	**High (5/5)**

MMAT results - studies investigating service use

	Non-randomised studies	Judy Foster 2002	James Munro 2005	James Munro 2000	D Dunt 2005	L Huibers 2013	P Sprivulis 2003	Morimura 2010	J Dale 2003
Screening questions	Are there clear research questions?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Do the collected data allow to address the research questions?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quality criteria	Are the participants representative of the target population?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Are measurements appropriate regarding both the outcome and intervention (or exposure)?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Are there complete outcome data?	Can't tell	Can't tell	Can't tell	Can't tell	Yes	Yes	Can't tell	Yes
	Are the confounders accounted for in the design and analysis?	Can't tell	Can't tell	Yes	No	Yes	Can't tell	Can't tell	Yes
	During the study period, is the intervention administered (or exposure occurred) as intended?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Quality score	**Medium (3/5)**	**Medium (3/5**	**High (4/5)**	**Medium (3/5)**	**High (5/5)**	**High (4/5)**	**Medium (3/5)**	**High (5/5)**

	Quantitative descriptive studies	Geraldine Byrne 2007	E Turbitt 2015	V Lattimer 2000	B Stewart 2006	J Turner 2013	N Siddiqui 2019
Screening questions	Are there clear research questions?	Yes	Yes	Yes	Yes	Yes	Yes
	Do the collected data allow to address the research questions?	Yes	Yes	Yes	Yes	Yes	Yes
Quality criteria	Is the sampling strategy relevant to address the research question?	Yes	Can't tell	Yes	Yes	Yes	Yes
	Is the sample representative of the target population?	Yes	Yes	Can't tell	Yes	Yes	Yes
	Are the measurements appropriate?	Yes	Yes	Yes	Yes	Yes	Yes
	Is the risk of nonresponse bias low?	Yes	No	Can't tell	Yes	Yes	Yes
	Is the statistical analysis appropriate to answer the research question?	Yes	Yes	Yes	Yes	Yes	Yes
	Quality score	**High (5/5)**	**Medium (3/5**	**Medium (3/5**	**High (5/5)**	**High (5/5)**	**High (5/5)**

	Mixed methods studies	A Mark 2003
Screening questions	Are there clear research questions?	Yes
	S2. Do the collected data allow to address the research questions?	Yes
Quality criteria	5.1. Is there an adequate rationale for using a mixed methods design to address the research question?	Yes
	5.2. Are the different components of the study effectively integrated to answer the research question?	Yes
	5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	Can't tell
	5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?	Can't tell
	5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	Can't tell
	Quality score	**Low (2/5)**

MMAT results - studies investigating user experience

	Qualitative Studies	J Goode 2011	Ewa Winneby 2012	A Björkman 2018	J Goode 2004
Screening questions	S1. Are there clear research questions?	Yes	Yes	Yes	Yes
	S2. Do the collected data allow to address the research questions?	Yes	Yes	Yes	Yes
Quality criteria	1.1. Is the qualitative approach appropriate to answer the research question?	Yes	Yes	Yes	Yes
	1.2. Are the qualitative data collection methods adequate to address the research question?	Yes	Yes	Yes	Yes
	1.3. Are the findings adequately derived from the data?	Can't tell	Can't tell	Yes	Yes
	1.4. Is the interpretation of results sufficiently substantiated by data?	Yes	Yes	Yes	Yes
	1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation?	Yes	Yes	Yes	Yes
	Quality score	**High (4/5)**	**High (4/5)**	**High (5/5)**	**High (5/5)**

	Quantitative descriptive studies	A O'Cathain 2014	M Rahmqvist 2011
Screening questions	S1. Are there clear research questions?	Yes	Yes
	S2. Do the collected data allow to address the research questions?	Yes	Yes
Quality criteria	4.1. Is the sampling strategy relevant to address the research question?	Yes	Yes
	4.2. Is the sample representative of the target population?	Can't tell	Can't tell
	4.3. Are the measurements appropriate?	Yes	Yes
	4.4. Is the risk of nonresponse bias low?	No	No
	4.5. Is the statistical analysis appropriate to answer the research question?	Yes	Yes
	Quality score	**Medium (3/5)**	**Medium (3/5)**

Mixed methods study	A McAteer 2016
S1. Are there clear research questions?	Yes
S2. Do the collected data allow to address the research questions?	Yes
5.1. Is there an adequate rationale for using a mixed methods design to address the research question?	Yes
5.2. Are the different components of the study effectively integrated to answer the research question?	Yes
5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted?	Yes
5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed?	Yes
5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved?	Yes
Quality score	**High (5/5)**

Supplementary table 1: Characteristics of patients and triage advice (9 studies that utilised routine data analysis)

First author Year Country Reference	Sample / data size	Staff conducting digital triage	Participants	Key findings relating caller/patient characteristics and triage advice
Payne 2001 England 23	56,450 calls	Nurse	General population	**Patient/symptom characteristics** • The patient was the caller in 45% of calls; 31% of calls were made by parents calling on behalf of their child. • 24% of calls were about 0-5 year olds. 22% were for 17-29 years, and 22% for 30-39 years. **Triage advice and urgency** •Urgency increased with age: 0-5 year olds were more likely to be categorised as "no urgency", 17-39 years were more likely to be "routine", and over 70s were more likely to be categorised as urgent. •56% of calls were prioritised as "no urgency", 32% were categorised as having some degree of urgency, and 11% were routine; 37% of patients were advised to self-care • Males were more likely to be categorised as urgent; females were more likely to be referred to community services or given information.
Elliot 2015 Scotland 5	1,285,038 calls	Nurse	General population	**Patient/symptom characteristics:** • Abdominal problems accounted for the largest proportion of calls (12.2%) followed by dental (6.8%) and rash/skin problems (6.0%). • Problems differed by age group. Rash/skin problems were most frequent in the under 5's, abdominal problems most frequent in 5-74, and breathing problems most frequent in over 75s. • Less affluent users tended to contact the service less often compared to affluent users, exceptions were for throat problems, genitourinary, eye problems and fever. **Triage advice and urgency:**

				• Out of hours calls most frequently resulted in: advice to visit an out-of-hours centre (34.1%), followed by a GP home visit (12.2%) or self-care advice being provided (10.2%). Whereas in-hours calls mainly resulted in: advice to contact a dentist (27.6%), a NHS 24 service clinician calling the patient (21.1%) or advice to contact a GP (19.2%).
Zwaanswijk 2015 Netherlands 25	895 253 patients	Nurse (within General practice cooperative)	General population	**Triage advice and urgency:** • Urgency variation was symptom specific: For Cystitis/Urinary Infections: 93.4% of variation ascribed to differing patient characteristics. For cystitis urgency was significantly lower for females and lower for adult patients; for lacerations and cuts: urgency significantly higher for patients over 5 years old than for younger children • Higher variation in urgency occurred at lowest two urgency levels.
Njeru 2017 USA 7	587 cases 587 controls	Nurse	Adult callers with and without limited English proficiency (LEP)	**Triage advice and urgency:** • Nurse recommendations for higher urgency care, (ambulance, visit the ED, or schedule an acute appointment) were more frequent for limited English proficiency callers (LEP) callers than non-LEP callers (49.4% versus 39.0%; P < 0.0004), differences remained significant after adjustment for co-morbidities. • The LEP patients were less likely to follow the recommendations given by the nurse, n (%): 339 (60.9%) versus 379 (69.4%) - even after adjusting for sex,co-morbidity, caller type (self or surrogate), duration of call, and recommended action
Jacome 2018 Portugal 24	148,099 calls	Nurse	General population (Older age groups 65+)	**Patient/symptom characteristics:** • Majority of users were female (63% vs. 37%), most users were younger than 80 years old (60.6% vs. 39.4%). Mean age: 77.3. • Most common symptoms were: pain (18.1%), respiratory tract infections (11.9%), digestive problems (8.6%), diabetes mellitus (6.4%) **Triage urgency and advice** Users in the “oldest old” group were more often referred to ED (51% vs. 40% of those in the “65–79 age” group) and less often advised to rely on self-care (11% vs. 15%).

Hsu 2011 England 21	402,959 calls about older people (In 12-month study period)	Nurse	Older age groups (aged over 65 years)	**Patient/Symptom characteristics** • The age of the callers ranged from 65 to 109 years (mean = 76.78; median = 76; Standard Deviation =7.856; mode = 65). During the study period, the estimated proportion of people aged 65 years and over was approximately 16% of the England and Wales population, but accounted for only 7.2% of service use. • Amongst older adults, service use increased with age, with higher use among women than men **Triage advice and urgency** Overall, the largest advice category was to visit GP, primary care service (PCS) or dentist on the same day: 28%, (n = 112,778), followed by home care 25.4% (n = 102,406) and being advised to see their GP, PCS or dentist, either routinely, 15.2%(n = 61,419) or urgently 14.7% (n = 59,154), being referred to the emergency service 6.9% (n = 27,612), ED 5.4%(n = 21,650) and community services 2% (n = 7,931).
Cook 2013 England 20	358 503 calls	Nurse	children aged 0–15 (<1, 1–3 and 4–15 years))	**Patient and symptom characteristics** • For infants aged <1, highest call rates were found for 'crying'' • High call rates were also found for symptoms relating to 'skin/hair/ nails' and 'colds/flu/sickness' for all age groups; self-care and health information was provided to 59.7% and 51.4% of these cases respectively. **Triage advice and urgency** • 47% calls made on behalf of children aged <1, 48.7% of calls for children 1–3 and 43.9% of calls for children aged 4–15 were managed with no onward referral needed by giving health information and advice •For children aged <1, only 7% of calls were forwarded to A&E, which was markedly higher for children aged 1–3 (12.3%) and for children aged 4–15 (13.5%). However, for GP outcomes (urgent/same day/routine), this was higher for children aged <1 (30%) than for children aged 1–3 (24.5%) and 4–15 (23.5%) •The symptoms which contributed to the highest number of high urgency calls related to 'respiratory tract' (n=840, 5.1%, ASR=32.7) and 'neurological disorders' (n=51, 8.4%,

				ASR=12.1)
North 2010 USA 22	20,230 calls over a 2 year period	Nurse	General population (users with insurance and subscription)	**Patient characteristics (seriousness of symptoms as investigated through hospitalisation rates).** This study compared hospitalisation rates in 3 groups, patients who: 1) were digitally triaged, 2) made a GP visit and 3) attended ED. •Triaged patients are more likely to result in hospitalisation as compared to those visiting a GP; but less likely than those attending ED. •3% (n=547) of callers were hospitalised. Hospitalisation rate varied by age: low (2%) for ages 3 – 17 to high (10%) for 65+ •Hospitalisation following triage call occurred quickly: 77% occurred with 48 hours of the call •Those aged 65 years + were 5 times more likely to have problems requiring hospital admission when presenting to the ED compared to callers. •Symptom calls in the 65 years and older age group had hospitalization rates close to 10%, •Findings relating to symptoms: for adult abdominal pain, rates of hospitalisation between callers and ED attendees were similar. •There was a higher proportion of female callers compared to female ED attendees and GP visits (females made up 72% of callers, 61% of GP visits and 56% of ED visits)
North 2010 USA 19	163,608 calls	Nurse	General population (users)	**Patient/symptom characteristics** • Study compared surrogate (calls made by someone on behalf of the patient) calls to self calls, made by the patient themselves Adult calls accounted for 105,866 (65%) of the total calls, of these, 14,646 (14%) were made by surrogate; men and the elderly were the two most over-represented groups in surrogate calls • For surrogate calls, the top 5 symptoms were: abdominal pain, vomiting or nausea, other, skin problems, dizziness. In self calls the top symptoms were: abdominal pain, skin

	problems, chest pain, other, eye or vision problems. •Vomiting or nausea, dizziness or light-headedness, and other were significantly more likely to be reported by surrogate callers. Abdominal pain, skin problems, chest pain, and eye or vision problems were significantly more likely to be reported by self callers •Surrogate calls, as a percent of total calls by age group, increased with the age of the patient •Calls concerning women patients made up 70% (n=74,069) of all adult calls, of which 9% (n=6780) were made by surrogates. Of the 31,797 calls about male patients, 25% (n=7866) were made by surrogates. Overall, males were the subject of 54% of surrogate calls and 26% of self calls. **Triage advice and urgency** • Emergency advice was recommended 28% (n=29,371) of all calls. 38% (n= 5545) of surrogate calls ended with this nurse recommendation compared to 26% (n=23,826) of self calls (OR 1.72; 95% CI 1.66 to 1.79). • Advice urgency increased with age for both surrogates and self calls

Supplementary table 2: Change in wider healthcare service use following digital triage implementations (8 studies)

First author Year Country Reference	Study type	Sample / data size	Staff conducting digital triage	Participants	Comparator	Findings relating to change in wider health care service use (primary care, hospitalisations, ambulance services, ED attendance)
Lattimer 2000 England 32	Cost effectiveness report of controlled trial	>14000 Control group (n = 7308 calls) Intervention group (Nurse telephone consultation): (n=7184 calls)	Nurse (within general practice cooperative)	General population	Usual care (referral to a GP)	***Primary care:*** During intervention period GPs made 428 fewer home visits, generating savings of £3360 (£2578 to £4198) in a year. ***Hospitalisations:*** The cost of providing nurse telephone consultation was £81 237 per annum; cost savings were estimated to be £94 422 due to reduction of other costs for the NHS arising from reduced emergency admissions to hospital.
Munro 2000 England 29	Routine data analysis	Study corresponds to the 1st year of operation: 68 500 NHS direct calls from the 1.3 million people served.	Nurse	General population	Service use in regions with no NHS direct	***Primary care:*** There was a significant decrease in use of GP cooperatives at sites using digital triage: change in estimated trend from increase of 2.0% per month before to − 0.8% afterwards (estimated relative change − 2.9% (95% confidence interval (CI)− 4.2% to − 1.5%). compared to negligible change in control: from 0.8% a month before to 0.9% afterwards (relative change 0.1%; CI: − 0.9% to 1.1%)) ***Ambulance services:*** Changes in trends were small and non-significant ***ED attendances:*** Changes in trends were small, variable and not significant.

Dale 2003 England 36	Controlled trial	635 calls digitally triaged by ambulance service; 611 non-triaged calls	Nurse and paramedic	Callers to emergency service for non-emergency concern (aged 2+)	Usual care (ambulance dispatch)	***Ambulance services:*** 52% (n=330) of calls were triaged as not requiring emergency ambulance. Of these: 47% had moderate urgency: care needed within 24 hours; 26% needed a routine appointment; 27% self care sufficient. Overall, 9.8% of ambulances were cancelled in the intervention groups (where this was offered). ***ED attendances:*** In the intervention group: 81% of patients triaged as requiring ambulance call outs attended ED; 63.4% of patients triaged as not requiring ambulance attended ED. ***Hospitalisations***: Some inconsistency in triage: 10% of those triaged as not requiring ambulance dispatch subsequently required hospital admission
Mark 2003 England 46	Mixed methods (routine data analysis + observation, interviews)	Numbers of calls analysed across three years: 5126 (year 1998) 5702 (1999) 4698 (2000)	Nurse	General population	Service use before implementation	***Primary care:*** Two main 'transitions': 1.Inital increase in GP cooperative workload and in-hours calls. Followed by fall in OOH GP co-operative workload by 18%. Use of primary care centres declined following the arrival of NHS Direct; allocation of home visits initially increased then decreased; OOH doctor advice progressively increased. Within older age groups: decline in both use of primary care centres and home visits, but a rise in doctor advice. ***ED attendances:*** Progressive increase in ED attendance
Dunt 2005 Australia 30	Four controlled trials	Random sampling (350 households per trial site)	Nurse (Two "standalone" call centres)	General population	1. Service use before implementation 2. Implementation of two	***Primary care***: Some types of out of hours care became more frequent in sites using digital triage services ***Ambulance services:*** Overall no change in any site

					telephone triage sites within existing 'embedded services' using paper based protocols	
Munro 2005 England 28	Surveys with care providers	571 surveys sent (188/297) responses from GP cooperatives, (35/35) for ambulance services and (200/239) for emergency departments	Nurse	General population	Service use before implementation	***Primary care:*** The 3 year period following digital triage implementation was associated with a reduction in calls to OOH general practice. In the context of an underlying trend of demand rising by about 1% each year, the introduction of digital triage was associated with an immediate 3% fall in demand coupled with a reversal of the trend so that demand began to fall by almost 8% per year ***Ambulance services***: No significant change in emergency ambulance service use. ***ED attendances:*** There was negligible change in use of emergency departments,.
Morimura 2010 Japan (Tokyo) 35	Routine data analysis (+ surveys with patients)	26,138 telephone consultations	Nurse and non-clinical call handler	General population	Service before implementation,	***Ambulance services:*** Number of ambulances used per 1 million was statistically reduced compared with that of the previous year: 46 846 vs. 44 689, p<0.0001. The out of hours ambulance use per 1 million people was also significantly reduced: 31 965 vs. 30 370. *Hospitalisations*: In those who were referred to a hospital by an ambulance (n =3252) 30.8% (1000 cases) were hospitalised. The emergency hospitalisation rate (EHR) decreased annually before the introduction of digital triage service. However, the rate after its introduction was statistically higher 36.5% vs. 37.8%,

						p<0.0001)(EHR increased following the introduction of the service).
Turner 2013 England 38	Routine data analysis	400,000 calls in first year of operation analysed.	Non-clinical call handler	General population	Control sites selected to match equivalent geographical areas	***Primary care:*** In one site - statistically significant reduction in urgent care attendances; 3 sites: reduction in calls to former (nurse led) digital triage service. Overall no change in primary care could be attributed to implementation ***Ambulance services:*** Reduction in ambulance emergency calls in 1 site and an increase in another site; All sites showed increase in emergency ambulance incidents. Overall no change in emergency service (999) calls were attributable to implementation ***ED attendances:*** Overall no change could be attributed to implementation

Supplementary table 3: Studies investigating patient level outcomes: service use, adherence with advice and hospitalisations (6 studies)

First author Year Country Reference	Study design	Sample / data size	Staff conducting digital triage	Participants	Comparison groups used in analyses	Key patient level service use findings
Foster 2003 England 27	Routine data analysis & data linkage	4493 calls, of which 193 were advised to go to ED	Nurse	General population	Three groups: 1) Callers triaged to ED who attended ED 2) Callers triaged to ED, who did not attend 3) Callers who received different triage advice who attended ED	***ED Attendance*** 8 % (358 of 4493) of callers were advised to attend ED. Of these, where data was available, 64.2% (124 of 193) followed the advice to visit ED with the same presenting complaint. • 2.4% (99 of 4135) went to ED for the same presenting complaint as their contact following triage despite being given other advice ***Hospitalisations*** 66.9% (83 of 124) of those attending ED after being advised to were sent home without further referral. However, 10 were referred on within the hospital and seven were admitted. 0.3% of callers (15 of 4235) who were not advised to attend A&E and were subsequently admitted raised concerns about the quality of triage.
Sprivulis 2004 Australia 34	Routine data analysis & data linkage	13,019 presentations to ED	Nurse	General population	Two groups: 1) ED users called a digital triage service in 24 hours prior to attending ED 2)ED users not digitally triaged	***ED Attendance*** 6.5% (842 of 13019) of patients attending ED had contacted the digital triage service in 24 hours prior to attendance. ***Hospitalisations*** For those triaged to 'immediate/prompt care' and 'non-urgent' care by HD and who presented to the ED (in the latter group, against the triage advice), there was a similar hospital admissions rate and ED triage distribution.
Stewart 2006 England 37	Routine data analysis & data linkage	3312 calls to NHS Direct North West Coast,	Nurse	Children and young adults aged under 16	Two main matched patient groups: 1) Patients advised, through digital triage, to attend A&E in the last 12	***ED Attendance*** •88% of those digitally triaged to attend ED did so within 1 hour. • 88% of those advised to take another course of action attended A&E within 4 hours. • Some indication that those triaged presented with higher urgency complaints, based on higher urgency advice within ED triage using “Manchester triage group 5-point system” for digitally

		and 14,029 patients who attended ED (between the 1st of Decembe r 2002and 28th of February 2003)			hours (n = 299) 2) Patients given alterative triage advice, but who still attended ED (n=163) Additional groups: Those attending ED who were GP referred and self-referred.	triaged patients, compared to self-referrals. •74% of digitally triaged patients were discharged home compared to 56% of those referred by GPs and 64% of those who self referred. • ***Hospitalisations:*** 27% of GP referrals, 10% of the self-referral group and 15% of NHS Direct referrals were admitted. Of those admitted patients referred by NHS Direct 52% were advised to attend A&E, and 48% were given other advice.
Byrne 2007 England 26	Surveys	268 callers	Nurse	Calls about abdominal pain, cough or sore throat	None	***General Practice use*** Among callers digitally triaged to self-care, 93% (64 of 69) reported that they had followed the advice to look after themselves at home, while five 7% (5 of 69) reported that they had chosen not to do so. Of the five, three said they had decided to go to their GP because, despite the advice of NHS Direct, they thought the condition was sufficiently severe to require such a visit. A further two said that their condition deteriorated after being triaged, so they then decided to contact their GP
Siddiqui 2019 Australia 39	Routine data analysis & data linkage	12,741 triaged cases linked to 72.577 ED presentati ons	Nurse	General population	n/a	***ED Attendance*** • Compliance with ED attendance advice was between 29-69% • There was higher compliance if ambulance was advised (53-69%) and • lowest compliance when self-transport to ED was recommended (29%). • Appropriateness of attendance to ED for those using TTAC was comparable to those who hadn't been triaged by TTAC. • 4% of ED presentations between 2016-2017 had contacted the digital triage service

Turbitt 2015 Australia 31	Surveys	1150 parents attending ED	Nurse	Parents of children	Some comparisons between parents who called and did not call the digital triage service.	***ED Attendance*** • 20% (230 of 1150) of parents had called the digital triage service ahead of ED attendance for their child's lower urgency concern • 70% of those digitally triaged attended ED because they were advised to attend. • 22% of those digitally triaged attended ED because they were still worried after receiving alternative digital triage advice (not to attend). • Of overall ED users: 16% of respondents had not heard of the digital triage service; 53% were aware of the service, but thought it would not be helpful.