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Service use, clinical outcomes and user experience associated with urgent care services that utilise 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 triage in urgent out of hours care.

Design Systematic review and narrative synthesis.

Methods Studies were identified through searches of Medline, Embase, CINAHL, Web of Science, and Scopus. All study types were included. Quality was assessed using the Mixed Methods Appraisal Tool (MMAT). 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 2020 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 is a comprehensive, mixed methods review covering a 20 year period, enabling evaluation of literature following shifts of some services to non-clinician led models of service delivery
- Outcomes relating to broader utilisation of services, cost effectiveness, and staff focussed 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, whilst in most other countries with a national help-line 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, there is limited evaluation of its impact on wider healthcare service use, clinical outcomes and user experience. No previous systematic reviews have focussed solely on services that utilise 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. It aims to evaluate wider health care service use, clinical outcomes and user experience related to its implementation in a range of urgent care settings in order to identify areas for improvement and the need for further research.

Method

This review is reported according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. See appendix 1 for the PRISMA checklist. The protocol has been published (https://rdcu.be/cdwOD)(14) and is registered on PROSPERO (2020 CRD42020178500).

Patient and public involvement (PPI)

This review forms the first stage of a wider project investigating patient and carer outcomes relating to telephone based digital triage, which aims to contribute towards improved service delivery and user experience. In the wider project, patient and participant input, through 1-1 discussions, has been sought in the design, and will be included at later stages of interpretation and dissemination of findings.

Eligibility criteria

1. *Population:* studies that evaluated digital triage in the general population or within population sub-groups (for example older people).
2. *Interventions:* studies that assessed telephone based digital triage:
    a. In services operating out of hours to provide urgent care
    b. That was used in the general population (not condition specific services);
    c. That results in signposting advice (referral to a local service such as ED, GP or ambulance dispatch) and/or 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 in the last 20 years 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 general practice) were used, the Medline search terms are provided in appendix 2. The search was restricted to studies published between the years 2000 – 2020 in English, including electronically published (Epub) studies ahead of print. Reference hand-searches were conducted for all included full texts.

Study selection and data extraction

Articles were de-duplicated 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 developed (appendix 3).

A data extraction form was developed and initially piloted on three studies to confirm that key elements of studies were captured. See appendix 4 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)(15). Based on the number of MMAT criteria met, studies were categorised as high (if all five MMAT criteria were met), medium (if 3 or 4 criteria were met) or low quality (if 2 or less criteria were met).

Data synthesis

Narrative synthesis(16) 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(16). Statistical meta-analysis was not possible due to the heterogeneity of the included studies.

Results

Thirty-one studies were included, most were of quantitative design (n=25)(5, 7, 17-39) including: routine data analyses(n=16)(5, 7, 17-23, 25, 27, 32, 33, 35-37), surveys(n=6)(24, 26, 29, 31, 38, 39), controlled trials (n=2)(28, 34), and a quantitative descriptive study (n=1)(40). There were fewer qualitative (n=4)(41-44) and mixed methods studies (n=2)(6, 45).

Studies were mainly from the UK (n=17)(5, 6, 18, 19, 21, 24-27, 30, 34-36, 38, 41, 42, 45), with small numbers from Sweden (n=4)(39, 43, 44, 46), Australia (n=4)(28, 29, 32, 37), USA (n=3)(7, 17, 20), Netherlands (n=2)(23, 31), Japan (n=1)(33) and Portugal (n=1)(22). Most included the full range of service users (n=24)(5, 6, 17, 19-24, 26, 28, 30-34, 36-39, 42-45), but some focussed on subsets: older adults(19, 22), younger age groups(18, 35), parents of children(29), men(41) or adults with limited English proficiency(LEP)(7).

Most studies evaluated digital triage conducted by nurses (n=26)(5, 7, 17-32, 35, 37, 39, 41-45), but some included non-clinicians (n=3)(6, 36, 38), nurses and paramedics (n= 1)(34), or nurses and non-clinical call handler (n=1)(33).

Most studies were of identifiable call centre-based services: England's former NHS Direct(18, 19, 21, 24, 26, 27, 35, 41-43, 45) and current NHS 111 service(36, 38), Scotland's NHS24(5, 6), USA's MayoClinic(7, 17, 20), Portugal's Linha Saude 24(22), Swedish Health Direct(39, 43, 44), Australia's Health Direct(32). A few involved smaller scale 'unnamed' implementations(28, 37) or general practice cooperatives(23, 30, 31). Two were based in the emergency setting, one within an English ambulance service(34) and one of an emergency telephone service in Japan(33).

Nineteen studies were rated as being of high quality(5-7, 19, 21-24, 27, 31, 32, 34-37, 41-44), eleven medium(17, 18, 20, 25, 26, 28-30, 33, 38, 39) and one was low(45). Qualitative studies tended to be of higher quality, whilst quantitative studies were more variable. Table 1 shows characteristics of studies.

Table 1: Characteristics of included studies (31 studies)

Main outcome area	Author Year Country	Study design	Sample / data size	Urgent or Emergency care	Name of service / digital triage tool	Participant & service name	Comparator	Quality
User experience	Björkman 2018 Sweden	Qualitative: 'Netnographic' method using information from online forums using six step	Data collected from 3 online forums	Urgent	Swedish Healthcare Direct (Nurse)	General population	None	High
User experience	O'Cathain 2013 England	Quantitative: Survey	Survey sent to 1200 patients from 4 pilot sites, 1769 responded and were included for analysis	Urgent	NHS 111 (triage tool: NHS pathways) (Non-clinical call handler)	General population	None	Medium
User experience	McAteer 2016 Scotland	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	Urgent	NHS 24 (Non-clinical call handler)	General population (NHS 24 users and non-users)	Interviewees (from survey respondents) grouped into satisfied users, dissatisfied users and non-users	High

			semi-structured interviews					
User experience	Rahmqvist 2011 Sweden	Quantitative: Survey	Random sample of 660 callers, made at one SHD site in October 2008	Urgent	Swedish Healthcare Direct (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	Qualitative: Interview study	60 interviews.	Urgent	NHS Direct (Nurse)	General population	None	High
User experience	Winneby 2014 Sweden	Qualitative: Interview study	8 semi-structured interviews	Urgent	Swedish Healthcare Direct (Nurse)	General population	None	High
User experience	Goode 2004 England	Qualitative: Interview study	10 semi-structured interviews	Urgent	NHS Direct (Nurse)	Interviews focussed on men	None	High
Patterns of triage advice	Payne 2001 England	Routine data analysis	56,450 calls	Urgent	NHS Direct (Nurse)	General population	None - Comparisons within digital triage call data	High

Patterns of triage advice	Elliot 2015 Scotland	Routine data analysis	1,285,038 calls	Urgent	NHS24 (Nurse)	General population	None - Comparisons within digital triage call data	High
Patterns of triage advice	Zwaanswijk 2015 Netherlands	Routine data analysis	895 253 patients	Urgent	Digital triage within General practice cooperative (Nurse)	General population	Some comparison with non-digital triage	High
Patterns of triage advice	Njeru 2017 USA	Routine data analysis	587 cases 587 controls	Urgent	MayoClinic proprietary (ExpertRN: software) (Nurse)	Those aged over 18 - (callers with and without limited English proficiency)	Patients with limited English proficiency compared to English proficient	High
Patterns of triage advice	Jacome 2018 Portugal	Routine data analysis	148,099 calls	Urgent	Linha Saude 24 (Nurse)	General population (Older age groups 65+)	None - Comparisons within digital triage call data	High
Patterns of triage advice	Hsu 2011 England	Routine data analysis	402,959 calls	Urgent	NHSDirect (Nurse)	Older age groups (aged over 65 years)	None	High
Patterns of triage advice	Cook 2013 England	Routine data analysis	358 503 calls	Urgent	NHS Direct (Nurse)	children aged 0–15 (<1, 1–3 and 4–15 years)	Comparisons between age groups	Medium

Patterns of triage advice	North 2010 USA	Routine data analysis	20,230 calls to AMC	Urgent	Ask Mayo Clinic (triage tool: ExpertRN) (Nurse)	General population (those with access to AskMayo subscription and insurance)	3 comparison groups: 1. AMC callers;2. ED attendances 3. Office (GP) visits. (Comparison of hospitalisation following a call to AMC and hospitalisations after an office (GP) visit)	Medium
Patterns of triage advice	North 2011 USA	Routine data analysis	Over the three-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	MayoClinic (Triage tool: ExpertRN: a software) (Nurse)	General population (aged over 18)	Surrogate vs. self calls	Medium
Service use following triage	Lattimer 2000 England	Quantitative descriptive: Cost effectiveness report from controlled trial	>14000 Control group (n = 7308 calls) Intervention group i.e. Nurse telephone consultation	Urgent	Digital triage integrated within a general practice cooperative (Nurse)	General population	Usual care (referral to a GP) compared to nurse led digital triage	Medium

			(n=7184 calls)					
Service use following triage	Munro 2000 England	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	NHS Direct (Nurse)	All contacts with these immediate care services (at time spanning before and after introduction of NHS direct)	Service use in regions where NHS Direct was introduced, compared to regions with no NHS direct implementation	High
Service use following triage	Dale 2003 England	Controlled trial	635 triaged calls 611 non-triaged calls	Emergency	Computerised decision support system with emergency control room (Nurse and paramedic)	General population calling the emergency service for non-emergency concerns (only those aged 12+)	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	Routine data analysis & data linkage	4493 calls, of which 193 were advised to go to ED	Urgent	NHS Direct (Telephone Advice System software'TAS'). (Nurse)	General population	Three comparison groups: 1. Callers triaged to A&E who attended 2. Callers triaged to A&E who did not attend	Medium

							3. Callers with different triage outcome who attended A&E.	
Service use following triage	Mark 2003 England	Mixed methods (routine data analysis + interviews)	Numbers of calls analysed across three years: 5126 (year 1998) 5702 (1999) 4698 (2000)	Urgent	Pilot system within GP cooperative, which later became NHS Direct (Nurse)	General population	n/a	Low
Service use following triage	Sprivulis 2004 Austrailia	Routine data analysis & data linkage	13 019 presentations to ED of which 842 were identified as having contacted Health- Direct within the 24 h period prior to presentation.	Urgent	HealthDirect (Centramax computerized CDS) (Nurse)	General population All patients who contacted the HealthDirect service during the one year study period	Key groups Those who were triaged by SHD prior to attending ED and those who were not triaged.	High
Service use following triage	Dunt 2005 Australia	Quantitative: four trials including surveys (self-reported service use)	Random sampling (350 households per trial site)	Urgent	"proprietry health call centre software" (Nurse)	General population	2 sites using "standalone" telephone triage which used "call centre software" 2 embedded	Medium

							telephone triage sites using paper based protocols	
Service use following triage	Munro 2005 England	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	NHS Direct (Nurse)	Surveys sent to care providers (general use of services following NHS direct implementations)	n/a	Medium
Service use following triage	Stewart 2006 England	Routine data analysis & data linkage	3312 calls to NHS Direct (NHSD) North West Coast, and 14,029 patients who attended ED (between the 1st of December 2002and 28th of February 2003)	Urgent	NHS Direct (Nurse)	Children and young adults aged under 16	2 matched patient groups: 1) 299 NHSD patients (those advised by NHSD to attend A&E in the last 12 hours) and 2) NHSD-other: 163those given a different signpost, but who still attended A&E Additional groups: GP referred and self-referred (to A&E)	High

Service use following triage	Byrne 2007 England	Quantitative: Survey	268 callers	Urgent	NHS Direct (Nurse)	General public with 3 symptom types (abdominal pain or cough and/or sore throat)	None	High
Service use following triage	Morimura 2010 Japan (Tokyo)	Routine data analysis	26,138 telephone consultations	Emergency	Tokyo Emergency Telephone Consultation Centre: (#7119) / 'computer programmed medical protocols' (Nurse and call handler)	General population	None	Medium
Service use following triage	Huibers 2013 Netherlands	Quantitative: Questionnaires	7039 questionnaires returned (from a total of 13,953 sent)	Urgent	"computerised decision support" (Nurse)	General population (users who had a telephone contact with a nurse)	None	High

Service use following triage	Turner 2013 England	Routine data analysis	400,000 calls to NHS 111 in first year of operation analysed	Urgent	NHS 111(NHS Pathways) (Nurse)	General population	1. Intervention sites: four NHS111 pilot sites 2. Control sites (North of Tyne, Leicester, Norfolk) selected to match equivalent geographical areas Sites matched based on 18 criteria covering: demographics, lifestyle, health profile and health service use	High
Service use following triage	Turbitt 2015 Austrailia	Quantitative: Surveys	1150 parents attending ED (decline rate 19.9%)	Urgent	Victorian nurse-On-Call (similar to Australia's HealthDirect service) (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	Routine data analysis & data linkage	12,741 triaged cases linked to 72.577 ED presentations	Urgent	Service/tool name Not specified (Nurse)	General population	n/a	High

Patterns of use:

Nine studies focused on patterns of triage advice; all of the nine utilised routine datasets(5, 7, 17-23). Key findings are summarised in table 2.

Table 2: Characteristics of patients and triage advice (9 studies that utilised routine data analysis)

First author Year Country	Sample / data size	Name digital triage service /tool (Staff type)	Participants	Key findings relating caller/patient characteristics and triage advice
Payne 2001 England	56,450 calls	NHS Direct (Nurse)	General population	**Patient/symptom characteristics** • The patient was the caller for 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** • 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. •The majority of calls were prioritised as "no urgency" (56%), 32% were categorised as having some degree of urgency, and 11% were deemed to be routine; Majority of patients were advised to self-care (37%) • n=10,815 referred to a GP, n=2288 referred to A&E, n=2272 referred to community services, n=442 callers referred to ambulance services. Respectively: 29% GP, 6% A&E, 6% community services;1%ambulance • 0-5 year olds were more likely to be referred to a routine GP appointment or given self-care advice. 17-29 year olds were more likely to be referred to community services or given information. The 30-39 year olds were more likely to be given information or referred to a routine GP appointment. • The over 70s were more likely to have an urgent referral to a GP • Males were more likely to be categorised as urgent & females were more likely to be referred to community services or given information.
Elliot 2015	1,285,038 calls	NHS24 (Nurse)	General population	**Patient/symptom characteristics:** •Abdominal problems accounted for the largest proportion of calls

Scotland				(12.2%) followed by dental (6.8%) and rash/skin problems (6.0%). • Problems differed more by age group. Rash/skin problems commonest in the under 5's, abdominal problems in 5-74, and breathing problems commonest in those over 75. • Less affluent users tended to contact NHS 24 less often for more problems 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%), 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 (17.2%).
Zwaanswijk 2015 Netherlands	895 253 patients	Digital triage within General practice cooperative (Nurse)	General population	**Triage advice and urgency:** •Variation in urgency occurred at lowest two urgency levels: 4 and 5 (5 is self care). • Urgency variation was symptom specific: For Cystitis/Urinary Infections: 93.4% of variation ascribed to variations in patient characteristics. For cystitis urgency was significantly lower for females and lower for adult patients; Lacerations and cuts: urgency significantly higher for patients over 5 years old than for younger children
Njeru 2017 USA	587 cases 587 controls	MayoClinic proprietary (ExpertRN: software) (Nurse)	Adult callers with and without limited English proficiency (LEP)	**Triage advice and urgency:** •Nurse recommendations for higher acuity care, (call an ambulance, visit the ED, or schedule an acute appointment) were more frequent for 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, Charlson co-morbity index(CCI),caller type (self or surrogate), duration of call, and recommended action
Jacome 2018 Portugal	148,099 calls	Linha Saude 24 (Nurse)	General population (Older age groups 65+)	**Patient/symptom characteristics:** • Majority of users female (63% vs. 37%), most users younger than 80 years old (60.6% vs. 39.4%). Mean age: 77.3, • Most common symptoms: pain (10.1%), respiratory tract infections(11.9%), digestive problems (8.6%), diabetes mellitus (6.4%), calls re one of these symptoms (51.8%). Urogenital disorder symptoms more frequently reported by men, 9.8% vs. 4.3%. **Triage urgency and advice** Users in the "oldest old" group were more often referred to an A&E (51% vs. 40% of those in the "65–79 age" group) and less advised to rely on self-care (11% of the "oldest old" vs. 15% of the elders younger than 80).
Hsu 2011 England	402,959 calls about older people (In 12-month study period)	NHSDirect (Nurse)	Older age groups (aged over 65 years)	**Patient/Symptom characteristics** • The age of the subject of the calls 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 [9], but accounts for only 7.2% of service use. • Older people use the service mainly for actual symptoms, usually with some level of urgency. Amongst older adults, service use increased with age, with a higher use among women than men. **Triage advice and urgency** Overall, the largest category was the person being advised to see their GP, PCS or dentist on the same day (n = 12,778, 28%), followed by home care

				(n = 102,406, 25.4%) and being advised to see their GP, PCS or dentist, either routinely (n = 61,419, 15.2%) or urgently (n = 59,154, 14.7%). The volume of calls being referred to 999 (n = 27,612, 6.9%), A&E (n = 21,650, 5.4%) and community services (n = 7,931, 2%) was relatively small.
Cook 2013 England	Calls: N=358 503	NHS Direct (Nurse)	children aged 0–15 (<1, 1–3 and 4–15 years))	**Patient and symptom characteristics** • For infants aged <1, highest call rates(CR) were found for 'crying': male (n=14, 440, CR=13.61) and female (n=13 654, CR=13.46) babies • High CRs were also found for symptoms relating to 'skin/hair/ nails' and 'colds/flu/sickness' for all age groups. NHS Direct was able to support patients to self-manage and provide health information for these symptoms for 59.7% and 51.4% of all cases respectively. **Triage advice and urgency** •The highest percentage of calls across all age groups were given health information and/or self-care advice, suggesting that a combined 47% of all calls made on behalf of children aged <1, 48.7% of calls on behalf of children 1–3 and 43.9% of all calls made by or on behalf of children aged 4–15 were managed with no onward referral needed. NHS Direct supported callers to self-manage their symptoms by giving health information, this included for: 'poisoning and overdose' , 'skin/hair/nail', 'wounds and injuries' and 'colds and flu/sickness' •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) with the highest number

				of outcomes being referral to the Emergency services(England's 999 service).
North 2010 USA	20,230 calls to Ask Mayo Clinic (over a 2 year period)	Ask Mayo Clinic (ExpertRN) (Nurse)	General population (those with insurance and access to AskMayo subscription)	**Patient characteristics (seriousness of symptoms as investigated through hospitalisation rates).** This study compared hospitalisation rates in 3 groups: digital triage, office visit, ED visit: •Telephone triage calls are more likely to result in hospitalisation than office visit; but less likely than ED visit. Odds of hospitalisation were 20 times greater than office visit. Odds of hospitalisation 3 - 5 greater in ED compared to AMC. Odds of hospitalisation increased with age. AMC calls had more similarities to ED visits than outpatient visits. •AMC calls: 547 (3%) of callers were hospitalised. Hospitalisation rate varied by age: low of 2% for ages 3 – 17/ High of 10% for 65+ •ED visits: hospitalisation from 4% (ages 3 – 17) to 35% for 65+; similar age trends across AMC and ED. Office visits: hospitalisation from 0.3% for all age groups, except 3 - 17 where it was 0.1% •Hospitalisation following call occurred quickly: 77% occurred with 48 hours •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 AMC and ED similar; opposite for diarrhoea: odds ratio was 19 for hospitalisation following ED compared to triage call •More female callers compared to female ED attendees (72% of callers

				but 61% of office visits and 56% of ED visits)
North 2010 USA	163,608 symptom calls made to the AMC centre.	MayoClinic (Triage tool: ExpertRN: a software) (Nurse)	General population	**Patient/symptom characteristics** • 163,608 symptom calls made in 3 year study period. Adult calls accounted for 105,866 (65%) of the total calls, of these, 14,646 (14%) were made by surrogate (by someone on behalf of a patient); men and the elderly were the two most over represented groups in surrogate calls • For surrogate calls with available data: the caller was a spouse in 4844 (49%), a parent or child in 3029 (31%), or a friend in 1187 (12%) of the calls. This varied by age. •In surrogate calls the top 5 symptoms were: Abdominal pain, vomiting or nausea, other, skin problems, dizziness. In self calls: 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 from 12% in the 18–34 year age group to 43% in the 80 and over age group. •Over half the calls (51%) for males 80 years and over were from surrogates while over one third of calls (39%) regarding women 80 and over were made by surrogates; males aged 35 to 80 years were the subject of about 60% of the surrogate calls. •Calls concerning women patients were 74,069 (70%) of all adult calls, of which 6780 (9%) were made by surrogates. Of the 31,797 calls about male patients, 7866 (25%) were made by surrogates. Overall, males were the subject of 54% of surrogate calls and 26% of self calls (OR 3.3; 95% CI 3.2

to 3.4).

Triage advice and urgency

• Emergency disposition was advised by the nurse in 29,371 (28%) of all calls. A total of 5545 (38%) of surrogate calls ended with this nurse recommendation compared with only 23,826 (26%) of self calls (OR 1.72; 95% CI 1.66 to 1.79).

• The proportion of emergency nurse disposition compared with routine disposition increased with age for both surrogates and self calls (P: 0.0001).

Characteristics of patients and callers

Presenting symptoms with highest frequency amongst callers, included: abdominal or digestive problems, 6.8% - 12.2% of calls(5, 17, 20, 22, 37); and respiratory problems, 11.3%(37) to 11.9%(22), of calls. The majority of calls were made by women (range: 59%-72%)(5, 17, 20-22, 37).

Calls about younger age groups(20, 21) made up a comparatively high proportions of calls; 24% of calls were for 0 – 5 year olds in one study(21) and another reported 15% of out of hours calls being for 0-4 year olds(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(21) (18); one study reported a high proportion (47%) of calls about children aged (0 – 15) were resolved through self-care advice or health information(18). Two studies reported that urgency increased with age(17, 22).

2) Sex: two studies reported women were more likely to receive lower urgency advice as compared to men; however, neither controlled for age or presenting symptoms(19, 21), one suggested this may be explained by women seeking care advice earlier, before their symptoms progress and become more urgent(19).

3) Symptoms: two studies reported symptoms associated with higher urgency advice(18, 23); for example, calls about children with respiratory problems were more likely to be referred to emergency care as compared to other symptom types(18).

4) Caller language proficiency: one case-control study reported that adults with limited English language proficiency (LEP) were more likely to receive higher urgency advice (ambulance, immediate

ED attendance or urgent visit) (49.4% versus 39.0%; P < 0.0004)(7); groups in this study were balanced based on age and sex and co-morbidities 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 health care service use (primary care, ED use, ambulance use, and emergency admissions) following implementation of digital triage(26-28, 30, 33, 34, 36, 45). Of these, one investigated non-clinician led triage(36). Comparators included: rates of service use in patients receiving usual care (e.g. GP referral) in comparison to those who were digitally triaged(30, 34); service use rates prior to implementation(26, 28, 33, 45); comparator regions with no digital triage implementation(27, 36); and national service use comparator(28).

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(45). 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(28).

Table 3 shows summarized findings.

Table 3: Change in wider healthcare service use following digital triage implementations (8 studies)

First author Year Country	Study type	Sample / data size	Digital triage service/tool name (staff type)	Participants	Comparator	Findings relating to change in wider health care service use (primary care, hospitalisations, ambulance services, ED attendance)
Lattimer 2000 England	Cost effectiveness report of controlled trial	>14000 Control group (n = 7308 calls) Intervention group (Nurse telephone consultation):(n =7184 calls)	Digital triage integrated within a general practice cooperative (Nurse)	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	Routine data analysis	Study corresponds to the 1st year of operation: 68 500 NHS direct calls from the 1.3 million people served.	NHS Direct (Nurse)	General population	Service use in regions with no NHS direct	**Primary care:** There was a significant decrease in use of GP cooperatives at NHS direct sites: change in estimated trend from increase of 2.0% per month before to − 0.8% afterwards (estimated relative change − 2.9% 95% confidence interval − 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% (− 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	Controlled trial	635 calls digitally triaged by ambulance service; 611 non-triaged calls	Digital triage within an emergency service (Nurse and paramedic)	Callers to emergency service for non-emergency concern (aged 2+)	Usual care (ambulance dispatch)	**Ambulance services:** 5% (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	Mixed methods (routine data analysis + observation, interviews)	Numbers of calls analysed across three years: 5126 (year 1998) 5702 (1999) 4698 (2000)	Pilot digital triage system within GP cooperative(Harmoni), which later became NHS Direct (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 (Harmoni) 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	Four controlled trials	Random sampling (350 households per trial site)	Two "standalone" call centres using digital triage telephone ("call centre software")	General population	1. Service use before implementation 2. Implementation of two telephone	**Primary care:** Some types of After Hours Primary Medical Care became more frequent in both digital triage services: Call centre: state-wide: Service use overall (95%CI: 1.03–1.83) and GP clinic use (95%CI: 1.07–2.00) increased in the metro area; and increase in GP clinic (95%CI: 1.04–2.13) and home visits (95%CI: 1.03–3.91) in the non-metro area **Ambulance services:** Overall no change in any site

			(Nurse)		triage sites within existing 'embedded services' using paper based protocols	
Munro 2005 England	Surveys with care providers	571 surveys sent (188/297) responses from GP cooperatives, (35/35) for ambulance services and (200/239) for emergency departments	NHS Direct (Nurse)	General population	Service use before implement-ation	**Primary care:** In first 3 years of operation, NHS Direct 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 NHS Direct 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:** NHS Direct was associated with negligible change emergency departments, and no different effect was found for the four paediatric emergency departments in the dataset
Morimura 2010 Japan (Tokyo)	Routine data analysis (+ surveys with patients)	26,138 telephone consultations	Tokyo Emergency Telephone Consultation Centre: (#7119) (nurse and non-clinical	General population	Service before implement-ation,	**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 after-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 the #7119 centre. However, the rate after its

			call handler)			introduction was statistically higher 36.5% vs. 37.8%, p<0.0001)(EHR increased following the introduction of the service). The after-hours EHR of ambulance cases for all cases and for adults was also higher after the introduction of the #7119 centre (A) than those of (B1) (all cases: 29.4% vs. 29.9%, p<0.0001
Turner 2013 England	Routine data analysis	400,000 calls to NHS 111 in first year of operation analysed.	Four sites using NHS 111 (NHS Pathways) (Non-clinician)	General population	Control sites (not using NHS 111) selected to match equivalent geographical areas	**Primary care:** In one site - statistically significant reduction in urgent care attendances; 3 sites: reduction in calls to NHSDirect. Overall no change in primary care could be attributed to NHS111. **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 attributable to NHS111 **ED attendances:** Overall no change could be attributed to NHS111

Patient level service use and adherence with advice

Seven studies reported varying patient adherence to triage advice through evaluation of patients' subsequent ED attendance(24, 25, 29, 32, 35, 37). Four utilised routine data and data linkage with sample sizes ranging from: 3312 to 13,019 triage calls. Of these, three studies reported 60% - 70% of patients who were advised to attend ED followed this advice(25, 32, 35); 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%)(35).

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)(24).

Four studies reported proportions of patients who attended ED after receiving triage advice: 2.4%(25), 9%(32, 35) and 22%(29). The latter included 51 of 1150 parents who had remained worried after calling the digital triage service(29). Results are summarised in table 4.

Table 4: Studies investigating patient level outcomes: service use, adherence with advice and hospitalisations (6 studies)

First author Year Country	Study design	Sample / data size	Name of service (staff conducting digital triage)	Participants	Comparison groups used in analyses	Key patient level service use findings
Foster 2003 England	Routine data analysis & data linkage	4493 calls, of which 193 were advised to go to ED	NHS Direct (Nurse)	General population	Three comparison 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	• Of 4493 calls to NHS Direct, 8% (n=358) were advised to attend A&E. In those advised to attend ED 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 with NHS Direct despite being given other advice. •***Hospitalisations:*** Most (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. 15 callers (0.3%) who were not advised to attend A&E and were subsequently admitted raise concerns about the quality of triage.
Sprivulis 2004 Australia	Routine data analysis & data linkage	13,019 presenta-tions to ED (842 had contacted HealthDirect in previous 24 hours)	HealthDirect (Nurse)	General population	Those who were digitally triaged prior to attending ED and those who were not. Also investigated: Patients triaged to immediate or prompt care -(Visit	• 13 019 presentations to ED of which 842 (6.5%) had contacted HealthDirect (HD) in 24 hours prior to attendance. • Percentages of patients who complied with recommended advice: HD triage to Immediate or prompt care: 61% (963/1579) / HD triage to non urgent 91% (2204/2416) •***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 advice), there was a similar hospital admissions rate

					ED) vs. patients triaged to non-urgent care (any non-emergency dispositions)	and ED triage distribution.
Stewart 2006 England	Routine data analysis & data linkage	3312 calls to NHS Direct North West Coast, and 14,029 patients who attended ED (between the 1st of December 2002and 28th of February 2003)	NHS Direct (Nurse)	Children and young adults aged under 16	2 matched patient groups: 1) NHSD callers: those advised by NHSD to attend A&E in the last 12 hours (n = 299) 2) NHSD-other: those given a different triage advice, but who still attended ED (n=163) Additional groups: Those attending ED who were GP referred and self-referred.	•88% of those advised by NHS Direct (NHSD) to attend A&E did so within 1 hour. • 88% of those advised to take another course of action attended A&E within 4 hours. The age distribution of patients attending A&E and those that called NHSD were generally similar. In both groups the majority of contacts were children under the age of 5 (20% were less than one year old). • The only significant difference in triage category was found to be in the green category (the A&E department uses the Manchester triage group 5 point system) where NHSD referred significantly less than self referrals. •74% of NHSD patients were discharged home compared to 56% of those referred by GPs and 64% of those who self referred. • ***Hospitalisations:*** 27% of GP referrals admitted, 10% of the self-referral group and 15% of NHS Direct referrals. Of those admitted patients referred by NHS Direct 52% were advised to attend A&E, and 48% were given other advice.
Byrne 2007 England	Surveys	268 callers	NHS Direct (Nurse)	Calls about abdominal pain, cough	None	Of 268 callers to NHS Direct, 69 (26%) were advised to self-care, 144 callers (54%) were advised to contact a GP, 51 (19%) were referred to an A&E department and four (1%) were referred to another service.

				or sore throat		Among the 69 callers advised to self-care, 64 (93%) reported that they had followed the advice to look after themselves at home, while five (7%) 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 in the time after their call to NHS Direct, so they then decided to contact their GP
Siddiqui 2019 Australia	Routine data analysis & data linkage	12,741 triaged cases linked to 72.577 ED presentations	Referred to as telephone triage advice service (TTAS) (Nurse)	General population	n/a	Compliance with ED attendance advice was between 29-69% with 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 for year 2016-2017 had contacted the digital triage service
Turbitt 2015 Australia	Surveys	1150 parents attending ED (decline rate 19.9%)	Victorian nurse-On-Call (NOC) (similar to Australia's HealthDirect service) (Nurse)	Parents of children	Some comparisons between parents who called and did not call but not clear 'There were no statistically significant differences among parents based on their demographic characteristics or	Of 1150 participants: 20% n=230 of parents had tried to call NOC ahead of ED attendance for their child's lower urgency concern Younger parents (under 30) more likely to call NOC than older parents (over 30): 24% vs.18%; p=0.04 More parents attending the ED at night had tried to call the NOC service compared with those presenting at other time bands (31% vs.17% during the day, 19% in the evening and 18% on the weekend) 85% of parents calling the NOC found it helpful 70% of ED users (of those triaged by NOC) came to the ED because they were told to by NOC; 22% of ED users (of those triaged by NOC) came because they were still worried after receiving different advice from NOC

time of ED visit.'	Of overall ED users: 16% of respondents had not heard of NOC; 53% were aware of NOC, but thought it would not be helpful A higher number of parents made a call to NOC if their child's chief complaint was illness, compared with parents whose children had injuries (25% vs. 10%; P< 0.001).

Safety

Four studies highlighted potential triage errors based on hospital admission rates(25, 32, 34, 35). These mainly related to potential 'under-triage', 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(25, 32, 34, 35).

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: n=261, 38%, 95% CI 34–41 vs. non-urgent: n=56, 37%, 95% CI 30–44)(32). 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(35).

Another study reported 15% (15 of 99) of patients given lower urgency advice than ED attendance, (such as urgent or routine GP appointment or self care), attended ED following their triage call and were admitted(25). One study reported 9.2%(30 of 330) of patients triaged as not requiring ambulance dispatch were subsequently admitted(25, 34).

One qualitative study described users reporting not having received appropriate triage advice for symptoms which later turned out to be more serious(43).

Service user experience

Seven studies focussed on user experience and satisfaction(6, 38, 39, 41-44). See table 5 for summary of findings.

1 **Table 5: Findings from studies that investigated user experience and satisfaction**

Author Year Country	Study type	Sample / data size	Name of service / digital triage tool- if applicable	Participants & service name	Key themes and example quotes
Björkman 2018 Sweden	Descriptive research design using information from online forums using six step 'netnographic' method	3 Swedish online forums were purposively sampled. Data collected from online forums	Swedish Healthcare Direct (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: doubt 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/ feelings that advice given was not appropriate, for example: nurse advised patient to stay at home for a condition that turn 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 &negotiation:*** *"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*:** dissatisfaction where this does not happen:

					"There's no point calling SHD. They send you to the ER where they yell at you for being stupid enough to listen to them. SHD is a big problem and seems to be at war with the ER"
O'Cathain 2014 England	Survey	Survey sent to 1200 patients from each of the 4 pilot sites studied, 1769 responded and were included for analysis	NHS 111 (triage tool: NHS pathways) (Non-clinical call handler)	General population (users)	***General satisfaction/attitudes*** Satisfaction (good overall 91% very satisfied or satisfied. Seventy-three percent (1255/1726, 95%confidence interval: 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 (53%), 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	Other - mixed methods	Age 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	NHS 24 (Non-clinical call handler)	General public (NHS 24 users and non-users)	***General satisfaction/attitudes:*** • Questionnaire findings: over 80% of those who had used the NHS 24 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: broadly satisfied with service. • Most common reasons for dissatisfaction related to initial triage questions ("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.

		used the NHS 24 service. Purposive sampling used for interview group with total of 30 being interviewed.			
Rahmqvist 2011 Sweden	Survey	Random sample of 660 callers, made at one SHD site in October 2008	Swedish Healthcare Direct (Nurse)	General public	***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 but felt they needed higher level of care; 3)other callers. Average global patient satisfaction was significantly lower for nurses who served the cases compared to those who had not served the cases: Global patient satisfaction: 3.2 in cases, 4.8 in controls, 6.4 in others
Goode 2004 England	Interview study	60 interviews.	NHS Direct (Nurse)	General public	***General satisfaction/attitudes*** Results related to feelings that NHSDirect was 'trustworthy', and being able to access care without being a 'nuisance'. Authors state that some interviewees experienced or predictions 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 reassurance / felt the service was caring: • "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'

Winneby 2014 Sweden	Interview study	8 semi-structured interviews	Swedish Healthcare Direct (Nurse)	General public	***The authors describe a theme of 'being believed and taken seriously'*** ***Experience of call taker: feeling reassured when taken seriously*** The authors describe findings relating to users feeling re-assured 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 et al	Interview study	Primarily focussed on 10 interviews with male callers	NHS Direct (Nurse)	Findings from interviews with men / findings that relating to men	***General satisfaction/attitudes (male users)*** • 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 . . . and he came off the phone – 'Oh that's no problem. He said a lady of 88 drank a full bottle and she was fine!" • The authors describe a male interviewee whose wife called on his behalf about his 'palpitations', "In line with their practice when someone makes a call on behalf of a patient who is capable of having a dialogue, NHS Direct had talked to him in person in order to assess his symptoms. Despite insisting that he had not been at all worried, he related having found the contact 'very reassuring'. 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, whilst 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.'

User experience

Three studies showed a high level of satisfaction amongst users(6, 29, 38). Two studies reported higher satisfaction amongst those who received higher urgency advice(38, 39). Two studies reported dissatisfaction with relevance and number of triage questions(6, 38).Three studies highlighted that callers felt they needed to be assertive in order to receive the expected care advice(41, 43, 44). 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"(43).

Two studies reported that users felt that the nurses using digital triage gave them time, conducted 'thorough' assessments and felt reassured(42, 44).

In contrast, one study of users who posted to an online forum reported feeling scrutinized by the nurses questioning their symptoms and need for care(43). Some expressed doubts about nurses' advice, competency and credibility(43).

Integration of services

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"(43).

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 (38).

Discussion

This systematic review has evaluated the evidence on how telephone-based digital triage affects wider health care 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 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 which highlighted potential safety concern relating to under-triage.

Overall user satisfaction with telephone 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(47).

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 evolving digital triage tools. Hence, there needs to be caution in the interpretation of the applicability of findings. 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(36), but this may not be applicable to all healthcare settings. One study of 'standalone' digital triage implementation showed an increase in GP clinic use(28), 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(28).

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. Whilst this tool worked well for many studies in this review, an acknowledged limitation(48) 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, cost effectiveness, and staff focussed outcomes were not covered.

Comparison with other literature

This review's focus is narrower, in terms of intervention and setting, compared to previous reviews(1, 10). A systematic review by Bunn et al. (including digital triage, non-digital triage and wider care settings) 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(47).

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 under-triage and subsequent hospitalisation ranging from 0.2% – 5.25%(1).

Although our review did not include broad utilisation outcomes, a previous study reported lower than expected use by some ethnic minority groups(49). 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.

We found that patients' adherence with advice varied by setting and study design. While very high adherence was reported in one survey based study(24), 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(13, 50).

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 sub-groups.

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.

Whilst 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 the 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.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

VS developed the review protocol, with the support of HA and JD. VS conducted searches. VS, CB, ES, JB conducted screening, data extraction and quality assessment. VS conducted the narrative synthesis with support from CB and HA. HA and JD reviewed and revised manuscript and approved the final version. VS in the guarantor for the review.

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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			

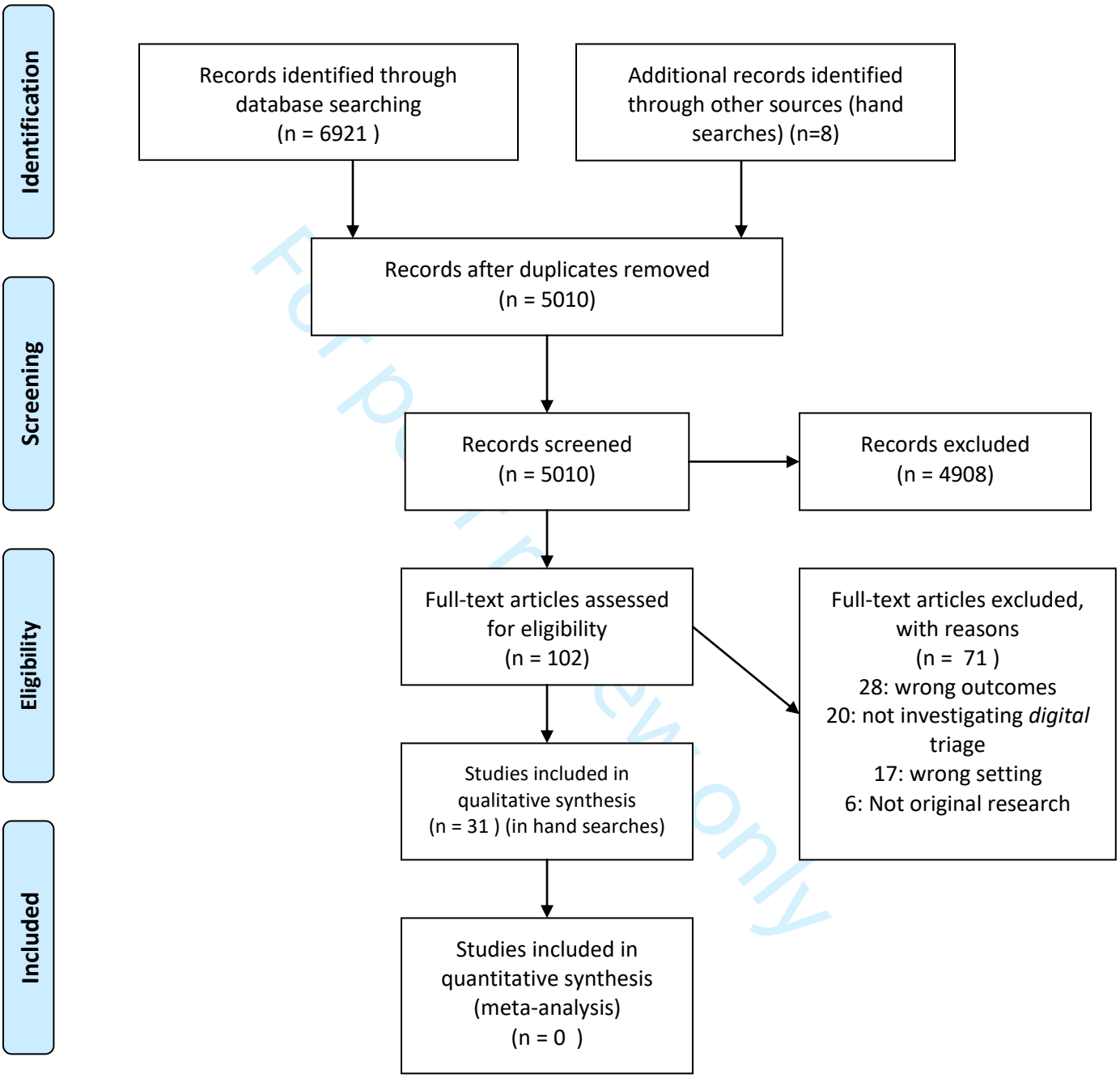
PRISMA 2009 Checklist

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

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*



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

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

Appendix 4

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).

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Systematic Reviews

PROTOCOL Open Access

An evaluation of service user experience, clinical outcomes and service use associated with urgent care services that utilise telephone-based digital triage: a systematic review protocol

Vanashree Sexton*, Jeremy Dale and Helen Atherton

Abstract

Background: Telephone-based digital triage is widely used by services that provide urgent care. This involves a call handler or clinician using a digital triage tool to generate algorithm-based care advice, based on a patient's symptoms. Advice typically takes the form of signposting within defined levels of urgency to specific services or self-care advice. Despite wide adoption, there is limited evaluation of its impact on service user experience, service use and clinical outcomes; no previous systematic reviews have focussed on services that utilise digital triage, and its impact on these outcome areas within urgent care. This review aims to address this need, particularly now that telephone-based digital triage is well established in healthcare delivery.

Methods: Studies assessing the impact of telephone-based digital triage on service user experience, health care service use and clinical outcomes will be identified through searches conducted in Medline, Embase, Cumulative Index to Nursing and Allied Health Literature (CINAHL), Web of Science and Scopus. Search terms using words relating to digital triage and urgent care settings (excluding in-hours general practice) will be used. The review will include all original study types including qualitative, quantitative and mixed methods studies; studies published in the last 20 years and studies published in English. Quality assessment of studies will be conducted using the Mixed Methods Appraisal Tool (MMAT); a narrative synthesis approach will be used to analyse and summarise findings.

Discussion: This is the first systematic review to evaluate service user experience, service use and clinical outcomes related to the use of telephone-based digital triage in urgent care settings. It will evaluate evidence from studies of wide-ranging designs. The narrative synthesis approach will enable the integration of findings to provide new insights on service delivery. Models of urgent care continue to evolve rapidly, with the emergence of self-triage tools and national help lines. Findings from this review will be presented in a practical format that can feed into the design of digital triage tools, future service design and healthcare policy.

Systematic review registration: This systematic review is registered on the international database of prospectively registered systematic reviews in health and social care (PROSPERO 2020 CRD42020178500).

Keywords: Digital interventions, Triage, Primary care, Urgent care, Emergency care, Telephone triage, Narrative synthesis

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Background

Telephone-based digital triage has been widely used by services that provide urgent care over the last several decades [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]. Within urgent care, different types of services utilise telephone-based digital triage, including national or regional help-lines, out-of-hours centres and emergency care providers. Examples of telephone-based services include England's National Health Service (NHS) 111 service, Scotland's NHS 24 service, Denmark's medical help line (MH1813), Australia's HealthDirect and the MayoClinic telephone service based in the USA [4–9].

Digital triage within these services involves a care service staff member using a digital triage tool to generate algorithm-based care advice, based on a patient's symptoms. Advice typically takes the form of signposting within defined levels of urgency to specific services, such as an emergency department (ED), out-of-hours centre, general practice (GP) appointment or self-care advice.

In part, these services have been implemented in response to increasing demand on primary care and hospital-based EDs over the last several decades [10]. They offer the potential to manage demand and improve consistency of care by providing a clear entry point or 'front door' to patients seeking care [11], which may simplify the patients decision on which service to access [12], and by providing appropriate advice based on the patient's symptom assessment [13]. There is a need for an up-to-date evaluation of the impact of these services on user experience, service use and clinical outcomes following triage, in order to evaluate success of these services and identify areas for improvement or further research.

Systematic reviews in this research area were conducted several years ago (between 2005 and 2012) [1, 10, 14–16]. Whilst their findings are useful in guiding research, in many cases, they have limited relevance as a result of the reorganisation of services in recent years [2]; an example of reorganisation is England's introduction of NHS 111 in 2011 [17], involving a workforce shift [18] away from the previous nurse led model to a non-clinician-led service [11]; this demonstrates the need to review more recent studies conducted within these services.

Despite wide adoption of digital triage within urgent care, previous reviews have not focussed on the digital triage element of services. In older literature, digital triage is often referred to as the use of computerised 'clinical decision support systems' (CDSS) in the context of telephone triage or consultation, as they were previously known [15]. Instead of focussing on digital triage, previous systematic reviews addressed broader review questions to evaluate telephone triage, including services that use digital triage and those that are not digitally supported [1, 10, 14] or evaluate the use of CDSS on patient outcomes in wider healthcare functions, ranging from digital triage within primary care to treatment management in intensive care units [15].

These previous reviews show mixed results in terms of service user experience, clinical and service use outcomes, which likely result from varying contextual factors, including whether services use digital triage, the type of service, care setting, levels of clinical supervision, types of staff conducting triage and level of staff training. Compared to previous reviews, this review addresses a more narrow review question, which is focussed on services that utilise digital triage in the provision of out-of-hours urgent care. We are excluding 'in hours' care as to date digital triage has not been widely adopted in these settings during usual business opening hours.

This review additionally addresses the need to evaluate more recent studies that have analysed large routine triage and patient outcomes datasets that have become more readily available in recent years [11]. Previous reviews included studies with quantitative designs only [10, 14, 15]; this review will additionally include studies exploring patient outcomes through qualitative or mixed methods approaches [17] and will therefore facilitate the integration of findings from studies with mixed designs. Integration will allow for better understanding of the impact of digital triage on service user and patient outcomes, which may provide insights for the future development of digital triage and policy related to such service developments. Findings could also feed into the design of the newly emerging patient self-triage approaches that are being adopted by care services [19, 20], for example the NHS 111Online, which allows patients to self-triage and receive care advice online [21].

Review question

How does telephone-based digital triage affect service user experience, clinical outcomes and health care service use in patients using out-of-hours urgent care services?

Objectives

This review will explore the objectives below in out-of-hours urgent care services that utilise telephone-based digital triage:

1. To describe characteristics of patients accessing these services and the triage advice they receive
2. To explore service user (patient or carer) experience of triage

3. To evaluate patient health care service use following triage, including hospital admissions, ED attendance and GP attendance.
4. To evaluate patient clinical outcomes, including hospitalisations and mortality

Methods

A completed Preferred Reporting Items for Systematic Review and Meta-Analysis Protocols (PRISMA-P) checklist [22] showing the recommended items to include in a systematic review is included in Additional file 1.

Eligibility criteria

Eligibility criteria have been developed using the population, interventions, comparators, outcomes and study designs (PICOS) principle [23] and will be applied to studies that are included in the review.

Population

The review will include studies that evaluate the use of triage in the general population or within particular subgroups of the general population (for example children or older people).

Interventions

The following eligibility criteria relating to the digital triage intervention will be applied to include:

1. Studies that assess the use of telephone-based digital triage in out-of-hours services that provide urgent care; these may include national or regional call centre-based urgent care telephone services, out-of-hours and urgent care centres and ambulance services. Services that only operate during 'in-hours' (for example, the use of digital triage for same day GP appointments) will not be included
2. Studies assessing the use of digital triage by the general population for any symptoms (not condition specific)
3. Studies assessing the use of digital triage that results in signposting (advising the patient to attend a local care service, such as an ED, an out-of-hours centre or advising the patient to book a GP appointment) and/or providing self-care advice

Outcomes

Studies that assess outcomes relating to at least one of the following outcomes will be included:

1. Characteristics of patients and triage advice
2. Service user (patient or carer) experiences
3. Health care service use following triage: including hospital admissions, ED attendance and GP attendance
4. Patient clinical outcomes, including hospitalisations (number of hospitalisations, duration of hospitalisation, type of hospitalisation) and mortality

Study designs

All study types will be included: qualitative (interviews, focus groups, ethnography), quantitative (cohort studies, cross-sectional studies, randomised controlled trials) and mixed methods studies.

Additionally, only studies published in the English Language in the last 20 years will be included (studies conducted from 2000 to 2020): this time period has been chosen to identify changes in outcomes over time in relation to changing models of service delivery, for example changes in workforce mix [2, 18]. Full inclusion and exclusion criteria can be found in Appendix 1.

Search strategy

Research databases will be searched using a search strategy and key words that have been developed with input from a librarian.

Search terms will include variations of terms relating to 'urgent care', 'triage' and 'digital'. Full search terms can be found in Appendix 2. A search will be conducted using the key words and Boolean strategies of 'AND' and 'OR'. The search terms will be modified as necessary according to the database being searched. The following databases will be searched: Medline (Ovid SP), Embase (Ovid SP), CINAHL, Web of Science and Scopus.

The search will be restricted to include studies published between the years 2000 and 2020, studies published in English, and studies electronically published (Epub) ahead of print.

Data management and screening

References identified in the searches will be managed in Covidence systematic review management software; identified references will be imported into Covidence and de-duplicated.

In the first screening stage, titles and abstracts will be screened against the inclusion and exclusion criteria by two reviewers independently. References that meet the inclusion criteria will be screened again for inclusion at full-text level, by two reviewers independently. For any full-text articles that are excluded, exclusion reasons will be documented using Covidence.

Any discrepancies on studies to be included at both screening stages will be resolved through discussion between the two reviewers. If a consensus is not reached, a third reviewer will be consulted. At the end of the two screening stages, a final set of studies to be included will be identified. The study selection process will be described through a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow chart [24].

Reviewers will independently extract relevant data from the included studies which will be recorded on a custom pre-defined data extraction form. The following information will be 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 and contextual factors (for example: staff experience and training, time that the service has been in place, level of support available to call takers). Data extraction discrepancies will be resolved through discussion between the reviewers, and a third reviewer will be consulted if necessary. Study authors may be contacted during the screening or data extraction where eligibility is unclear.

References of included studies will be screened by hand to identify any other eligible studies. Different reports that relate to the same study will be identified and labelled to indicate that they refer to the same study.

Risk of bias and quality assessment

Quality assessment will be conducted for all full-text peer-reviewed publications that fit the inclusion criteria, using the Mixed Methods Appraisal Tool version 2018 (MMAT) [25], which is designed to enable the assessment of mixed studies.

If the reviewers disagree in their assessment of bias in a study, this will be resolved though discussion. Quality assessment will not be used to exclude studies from the review but will be taken into account in the synthesised findings.

Different types of biases which may be present in each study will be considered and presented in a risk of bias table. If missing data or selective reporting of outcomes is apparent in a study, the study author will be contacted to obtain information on the reasons behind the missing data and to assess the risk of any systematic differences in missing data. Studies of equal quality as determined through assessment with the MMAT and risk of bias assessment will be considered to have similar weighting, and this will feed into the data synthesis to ensure trustworthiness of synthesis, serving to minimise bias.

Additionally, for quantitative studies, the occurrence of reporting (non-publication) bias will be evaluated by conducting checks of study registers (for example: ClinicalTrials.gov) to identify the completeness of the published literature included in the review; these findings will feed into the overall evaluation of the available evidence.

Strategy for data synthesis

A narrative synthesis approach will be used, which is a 'synthesis of findings from multiple studies that relies primarily on the use of words and text to summarise and explain the findings' [26]. This strategy has been chosen as the included studies are likely to be diverse in design and outcomes.

Narrative synthesis will be conducted to analyse, integrate and summarise the evidence identified through data extraction and the findings from quality assessment. An iterative approach will be followed, based on four main elements: (1) theory development, (2) preliminary synthesis, (3) exploring relationships between evidence from studies and (4) assessing robustness of the synthesis conducted [26]. Key sub-groups and subsets of data will be identified through narrative synthesis, based on the findings of the included studies.

Discussion

This review seeks to evaluate the impact of telephone-based digital triage by urgent care services on service user experience, and patients' clinical and service use outcomes. This is the first systematic review to evaluate these outcomes in relation to digital triage in the urgent care setting. In addition, this review includes mixed studies, enabling the integration of evidence from studies of wide-ranging design. It will be possible to investigate how findings have changed over time, by comparing results of studies carried out early in the implementation of these services as well more recent studies conducted in well-established services, and how other contextual factors influence findings. Urgent care delivery continues to develop rapidly; findings from this review will have potential to inform policy and practice related to the design and delivery of urgent care service delivery and should also highlight gaps in the evidence that require further investigation.

Registration of review

This review is registered on the international database of prospectively registered systematic reviews in health and social care (PROSPERO 2020 CRD42020178500). Amendments to the protocol will be amended on the registration.

Appendix 1

Table 1 Inclusion and Exclusion criteria

Inclusion	Exclusion
Studies assessing telephone-based digital triage	Studies assessing telephone triage that is not digitally supported (e.g. triage conducted through paper protocols) Studies assessing digital triage that is not telephone based (face to face)
Studies investigating telephone-based digital that is used for any/broad ranging symptoms (not condition specific)	Studies assessing the use of digital triage for specific conditions (for example, digital tools that provide patient condition self-management or Cognitive Behavioural Therapy would be excluded)
Studies investigating telephone-based digital triage that conducted by a member of health care service staff (clinician or non-clinician)	Studies investigating digital triage that used by a patient directly for self-triage (e.g. 111online)
Studies that examine the use of digital triage tools resulting in signposting and/or self-care advice for the patient: Examples of signposting include advice to the patient to book a GP appointment, attend ED, ambulance dispatch and self-care	Studies that examine the use of digital triage tools resulting in other types of advice (e.g. condition specific advice only)
Telephone-based digital triage in services that provide urgent care, predominantly out of hours, including: Call centre-based urgent care telephone services (examples: NHSDirect, NHS111), which may provide care 24/7 Out-of-hours and urgent care centres Out-of-hours services run by general practices Ambulance services (include only secondary triage of non-emergency calls, following initial assessment)	Studies in routine care settings. Exclude triage services that only provide in-hours digital triage (for example, those used within usual general practice opening hours only). Exclude triage that is utilised by hospital-based emergency departments, for example: the 'Canadian Triage and Acuity Scale' and the 'Manchester Triage System'
Studies assessing outcomes relating to: 1. Patterns of telephone triage service use by patients 2. Service user (patient or carer) experience 3. Service use following triage, including: ED attendance, GP attendance and hospitalisations) 4. Health outcomes following triage, including mortality and hospitalisations	Studies that only explore outcomes that are not in the included list: e.g. Studies that only explore experience of the staff member who uses the digital triage tool (e.g. non-clinician call handler for NHS 111, or nurse call taker for NHS Direct) Accuracy outcomes: relating to comparison of triage outcomes between types of professionals
Studies of any design will be included Examples: qualitative (interviews, focus groups, ethnography), quantitative (cohort studies, cross-sectional studies or RCTs) or mixed methods studies.	Reviews, discussion articles, conference abstracts, case reports
Studies published in English	Studies published in other languages
Studies published in the last 20 years	Studies published prior to 20 years ago

Appendix 2

Search terms

Table 2 Medline search terms

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.mp OR Ambulatory Care/ or ambulatory care.mp AND
Triage	Triage.mp OR Triage/ OR Telephone consultation.mp AND
Digital	Digital.mp OR Computer.mp OR Software/ or Software.mp OR Online.mp or Online Systems/ OR Internet.mp or Internet/ OR Web.mp or Web Browser/ OR Computerised.mp OR Computerized.mp OR electronic.mp OR ECDS.mp OR CCDS* OR Decision Support Systems, Clinical/ OR Decision support*

Table 3 EMBASE search terms

Concept	Search terms
Care setting	Primary care.mp OR Primary Medical Care/ OR After hours Care/ OR Out-of-hours.mp OR out-of-hours care/ OR Emergency care.mp OR Emergency Health service/ OR emergency care/ OR Urgent care.mp OR Ambulatory Care/ OR ambulatory care.mp AND
Triage	Triage.mp OR Telephone consultation.mp OR teleconsultation/ AND
Digital	Digital.mp OR Computer.mp OR Software/ or Software.mp OR Online.mp or Online System/ OR Internet.mp or Internet/ OR Web.mp or Web Browser/ OR Computerised.mp OR Computerized.mp OR electronic.mp OR ECDS.mp OR CCDS* OR Decision Support Systems / OR Decision support.mp

Table 4 CINAHL search terms

Concept	Search terms
Care setting	'Primary care' OR (MH 'Primary Health Care') OR 'Out-of-hours' OR 'After-hours care' OR (MH 'Emergency Care') OR 'Emergency care' OR (MH 'Emergency Service') OR 'Urgent care' OR (MH 'Ambulatory Care') OR 'Ambulatory care' AND
Triage	(MH 'Triage') OR 'triage' OR 'Telephone consultation' AND
Digital	'digital' OR 'Computer' OR (MH 'Software') OR 'software' OR 'Online' OR (MH 'Online Systems') OR (MH 'Internet') OR 'Internet' OR 'web' OR (MH 'Web Browsers') OR 'Computerised' OR 'computerized' OR 'electronic' OR 'ECDS' OR 'CCDS' OR 'Decision support'

Table 5 Web of Science search terms

Concept	Search terms
Care setting	'Primary care' OR 'Primary Health Care' OR 'After-Hours Care' OR Out-of-hours OR 'Emergency care' OR 'Emergency Medical Services' OR 'Urgent care' OR 'Ambulatory Care' AND
Triage	Triage OR 'Telephone consultation' AND
Digital	Digital OR Computer OR Software OR Online OR Internet OR Web OR Computerised OR Computerized OR electronic OR ECDSOR CCDS* OR 'Decision support system'

Table 6 Scopus search terms

Concept	Search terms
Care setting	'Primary care' OR 'Primary Health Care' OR 'After-Hours Care' OR 'Out-of-hours' OR 'Emergency care' OR 'Emergency Medical Services' OR 'Urgent care' OR 'Ambulatory Care' AND
Triage	Triage OR 'Telephone consultation' AND
Digital	Digital OR Computer OR Software OR Online or 'Online Systems' OR Internet OR Web OR Web Browser OR Computerised OR Computerized OR electronic OR ECDS OR CCDS OR 'Decision support system'

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13643-021-01576-x.

Additional file 1. PRISMA-P checklist.

Abbreviations

CINAHL: Cumulative Index to Nursing and Allied Health Literature; PRISMA: Preferred Reporting Items for Systematic Reviews and Meta-Analyses; PRISMA-P: Preferred Reporting Items for Systematic Reviews and Meta-Analyses Protocols; GP: General Practice; NHS: National Health Service; CDSS: Clinical decision support system; ED: Emergency department; MMAT: Mixed Methods Appraisal Tool

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Amendments

This version 4 protocol was updated on 16 December 2020 to clarify the in-hours care setting.

Authors' contributions

VS developed the first draft of the protocol, with the support of HA and JD. HA and JD reviewed and revised the draft protocol. VS is the guarantor for the review. The author(s) read and approved the final manuscript.

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Availability of data and materials

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Ethics approval and consent to participate

Not applicable.

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Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Service use, clinical outcomes and user experience associated with urgent care services that utilise 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 01 March 2000 – 01 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 (MMAT). 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 outcome 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 2020 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 focussed 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, whilst 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 focussed solely on services that utilise 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 health care 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 appendix 1 for the PRISMA checklist. The published protocol (https://rdcu.be/cdwOD)(15) was followed and is registered on PROSPERO (2020 CRD42020178500).

Patient and public involvement (PPI)

No 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 (PICOS) principle (16):

1. *Population:* studies that evaluated digital triage in the general population or within population sub-groups (for example older people).
2. *Interventions:* studies that assessed telephone based digital triage, which met all of the below criteria:
    a. In services providing urgent care (excluding in-hours general practice)

b. That was used by the general population (not condition specific services);

c. 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 01 March 2000 – 01 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 general practice) were used. See Medline search terms in appendix 2. The search was restricted to studies published in English, including electronically published (Epub) studies ahead of print. Reference hand-searches were conducted for all included full texts.

Study selection and data extraction

Articles were de-duplicated 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 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 3 or 4 criteria were met) or low quality (if 2 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 visual summary was not possible due to heterogeneity of outcomes, findings were summarized 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 flowchart.

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 focussed 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 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 general practice 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.

Nineteen studies were rated as being of high quality(5-7, 21, 23-26, 29, 33, 34, 36-39, 42-45), eleven medium(19, 20, 22, 27, 28, 30-32, 35, 40, 41) and one was low(46). Qualitative studies tended to be of higher quality, whilst quantitative studies were more variable. Reasons for lower quality amongst quantitative studies included inadequate description of accounting for confounders (28, 30, 34, 35) and risk of non-response bias (31, 40, 41, 48). 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 appendix 4.

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 & 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 semi-structured interviews	Urgent	Non-clinical call handler	General population (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 semi-structured interviews	Urgent	Nurse	General population	None	High
User experience	Goode 2004 England	Qualitative: Interview study	10 semi-structured interviews	Urgent	Nurse	Interviews focussed on men	None	High

	(42)							
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 (general practice 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 - (called with and without limited English proficiency)	Patients with limited English proficiency compared to 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. 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 three-year period: 105,866 adult calls (65% of the total calls). Of these, 14,646 (14%) were made by a surrogate on	Urgent	Nurse	General population (aged over 18)	Surrogate vs. self calls	Medium

			behalf of the patient.					
Service use following triage	Lattimer 2000 England (32)	Quantitative descriptive: Cost effectiveness report from controlled trial	>14000 Control group (n = 7308 calls) Intervention group i.e. Nurse telephone consultation (n=7184 calls)	Urgent	Nurse (within general practice cooperative)	General population	Usual care (referral to a GP) compared to 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 to 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	The control group not offered triage was compared with calls digitally triaged either by nurses or paramedics.	High

						concerns (only those aged 2+)		
Service use following triage	Foster 2003 England (27)	Routine data analysis & data linkage	4493 calls, of which 193 were advised to go to ED	Urgent	Nurse	General population	Three comparison groups: 1. Callers triaged to A&E who attended 2. Callers triaged to A&E who did not attend 3. Callers with different triage outcome who attended A&E.	Medium
Service use following triage	Mark 2003 England (46)	Mixed methods (routine data analysis + interviews)	Numbers of calls analysed across three years: 5126 (year 1998) 5702 (1999) 4698 (2000)	Urgent	Nurse	General population	n/a	Low
Service use following triage	Sprivulis 2004 Australia (34)	Routine data analysis & data linkage	13 019 presentations to ED of which 842 were identified as having contacted Health- Direct	Urgent	Nurse	General population - all patients who contacted the digital triage service during	1. Patients who were digitally triaged prior to attending ED	High

			within the 24 h period prior to presentation.			the one year study period	2. Patients who were not digitally triaged	
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 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
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 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	Routine data analysis & data linkage	12,741 triaged cases linked to 72.577 ED presentations	Urgent	Nurse	General population	n/a	High

	(39)							

Patterns of use:

Nine studies focused on patterns of triage advice; all utilised routine datasets(5, 7, 19-25). Key findings are summarised below; detailed findings from studies are in supplementary table 1.

Characteristics of patients and callers

Presenting symptoms with highest frequency amongst patients, included: abdominal or digestive problems, 6.8% - 12.2% of calls(5, 19, 22, 24, 39); and respiratory problems, 11.3%(39) to 11.9%(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 year olds in one study(23) and another reported 15% of out of hours calls being for 0-4 year olds(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 to 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 to other symptom types(20).

4) Caller language proficiency: one case-control study reported that adults with limited English language proficiency (LEP) were more likely to receive higher urgency advice (ambulance, immediate ED attendance or urgent visit) (49.4% versus 39.0%; P < 0.0004)(7); groups in this study were balanced based on age and sex and co-morbidities 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 health care 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 (e.g. 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).

Supplementary 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 utilised routine data and data linkage with sample sizes ranging from: 3312 to 13,019 triage calls. Of these, three studies reported 60% - 70% 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 supplementary table 3.

Safety

Four studies highlighted potential triage errors based on hospital admission rates(27, 34, 36, 37). These mainly related to potential 'under-triage', 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 34–41 vs. non-urgent: 37% (n=56), 95% CI 30–44)(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 focussed on user experience and satisfaction(6, 40-45). Three studies reported a high level of satisfaction amongst users(6, 31, 40). Two studies reported higher satisfaction amongst 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 scrutinized 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.

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 & 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"*
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%confidence interval: 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 and sex-stratified random sample of 256 adults	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*

		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.			*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.
Rahmqvist 2011 Sweden (41)	Survey	Random sample of 660 callers, made at one site in	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)

		October 2008			other callers. Average global patient satisfaction was significantly lower for nurses who served the cases compared to 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'
Winneby 2014 Sweden (45)	Interview study	8 semi-structured interviews	Nurse	General public (users)	***Experience of call taker: feeling reassured when taken seriously*** The authors describe findings relating to users feeling re-assured 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/attitudes*** • 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 . . ." • The 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, whilst 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."

Discussion

This systematic review has evaluated the evidence on how telephone-based digital triage affects wider health care 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 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(49).

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. Whilst this tool worked well for many studies in this review, an acknowledged limitation(50) 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 utilise digital

triage (such as call volumes, call lengths and caller characteristics alone), cost effectiveness, and staff focussed outcomes were not covered.

Whist Patient and Public Involvement (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 to 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(49).

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 under-triage and subsequent hospitalisation ranging from 0.2% – 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(51). 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(13, 52).

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 sub-groups.

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.

Whilst 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(53); 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.

Data availability statement

All data relevant to the study are included in the article or uploaded as supplementary information

Ethics and dissemination

Ethnical approval was not required for this review as the data included were obtained from published, publicly available sources.

Competing interests

The authors declare that they have no competing interests

Funding statement

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Authors' contributions

VS developed the review protocol, with the support of HA and JD. VS conducted searches. VS, CB, ES, JB conducted screening, data extraction and quality assessment. VS conducted the narrative synthesis with support from CB and HA. HA and JD reviewed and revised manuscript and approved the final version. VS in the guarantor for the review.

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Figure Captions

Figure 1: PRISMA Flowchart

Figure 2: Findings from studies of service use after digital triage implementation

Figure 3: Key themes from studies of user experience

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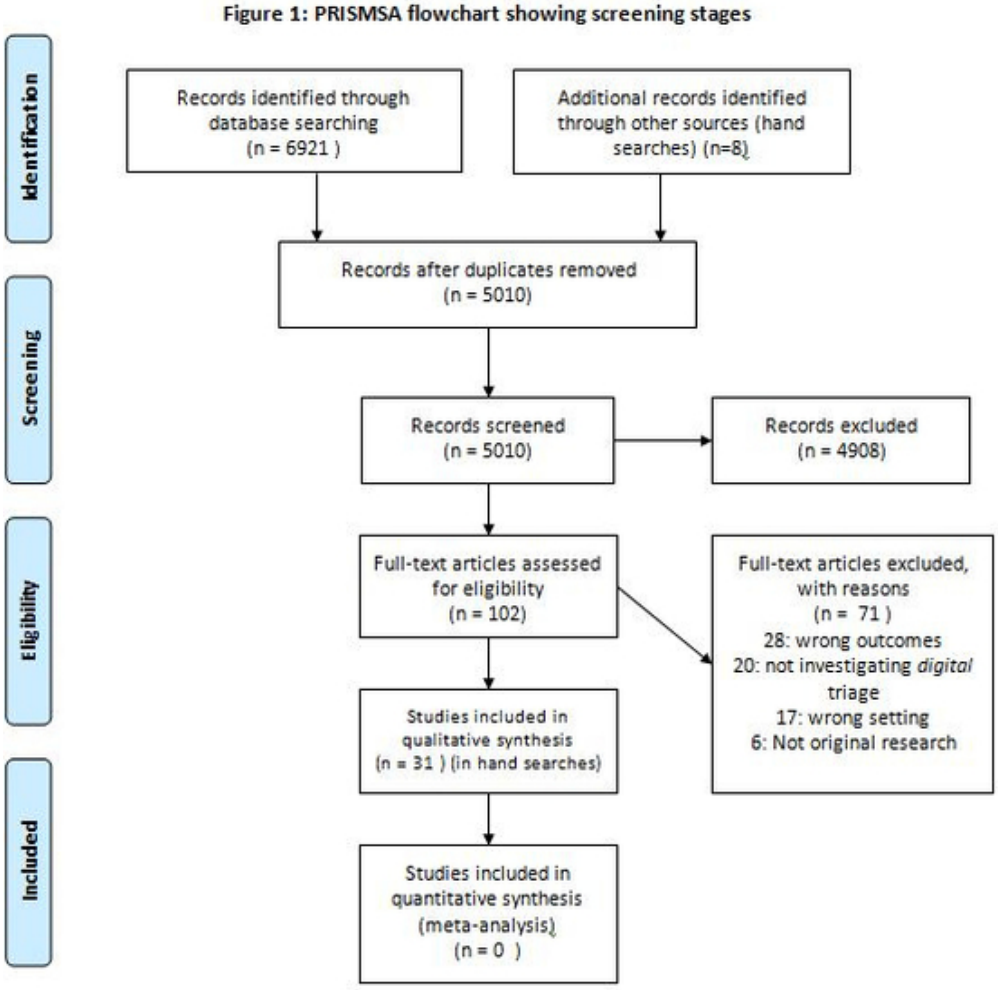

Figure 1: PRISMA Flowchart

46x47mm (300 x 300 DPI)

Figure 2: Change in service use after digital triage implementation and strength of evidence

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 service use after digital triage implementation

137x46mm (300 x 300 DPI)

Figure 3: Key themes and strength of evidence from studies of service user experience

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 (60)	✓			✓			
Winneby 2014 (45)	✓		✓	✓			
Goode 2004 (43)	✓		✓	✓			

Green = studies of high quality

Amber = studies of medium quality

Figure 3: Key themes from studies of user experience

112x43mm (300 x 300 DPI)

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

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 service ***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)(EHS 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.