


# BMJ Open Efficacy and safety of a digital check-in and triage kiosk in emergency departments: a systematic review protocol

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## ABSTRACT

**Introduction** Increasing demand for healthcare services worldwide has led to unprecedented challenges in managing patient flow and delivering timely care in emergency care settings. Overcrowding, prolonged waiting times, reduced patient satisfaction and increased mortality are some of the consequences of this increased demand. To address this issue, some healthcare providers have turned to digital systems, such as self-check-in kiosks, for efficient patient triage and prioritisation. While digital triage systems hold promise for efficient patient prioritisation, reduced data duplication, shorter waiting times, improved patient satisfaction, the impact on workflow, the accuracy of triage and staff workload require further exploration for successful implementation in emergency care settings. This systematic review aims to assess the efficacy and safety of digital check-in and triage kiosk implementation within emergency departments.

**Methods and analysis** A systematic review will be conducted in MEDLINE (Ovid), Web of Science, Scopus and Science Direct and will include quantitative and mixed method studies with a significant quantitative component, related to self-service kiosk implementation in emergency departments. The outcomes of interest will focus on the efficacy and safety of digital triage, including triage time, workflow, the diagnostic accuracy of triage and adverse events. Risk of bias will be assessed using the Cochrane Risk of Bias Tool. A narrative synthesis will be used to summarise the findings of the included studies.

**Ethics and dissemination** This review is exempt from ethical approval because it will be analysing published studies containing non-identifiable data. The findings will be disseminated through peer-reviewed publications.

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## INTRODUCTION

Healthcare systems worldwide are grappling with continuing growth in demand across primary, secondary, urgent and emergency care. These challenges are driven in part by an ageing population and greater case complexity, with increasing numbers of individuals living with multiple long-term conditions (multimorbidity now affects over a quarter of people in England).<sup>1–3</sup>

This universal growth in demand has an impact across health sectors, compelling

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ As digital kiosks in emergency settings are relatively new, there may be limited prior research leading to challenges in drawing robust, generalisable conclusions.
- ⇒ In a relatively novel area of research, variability in the description of interventions may create difficulty in identifying relevant studies.
- ⇒ Given the likely variability in study designs and quality in the included literature, synthesising the findings may be challenging due to the potential heterogeneity among the studies.

patients to seek support in emergency care settings when access to healthcare alternatives is limited. This has led to unprecedented challenges in the management of patient flow and delivering timely care within urgent and emergency care departments. A growing influx of patients seeking urgent medical attention has resulted in severe overcrowding and negatively impacted patient satisfaction, staff and clinical outcomes.<sup>4</sup> Prolonged waiting times (specifically including time-to-identification, time-to-triage and time-to-treating-physician), delayed care delivery, increased stress, decreased productivity and higher mortality rates are concerning consequences of this issue.<sup>5 6</sup> Consequently, many health systems, including the UK National Health Service, are increasingly turning to technological solutions to address the problem of healthcare demand management in urgent and emergency care.

Some healthcare providers have adopted digital systems, such as digital self-check-in kiosks in waiting rooms of emergency departments (EDs) and urgent care centres (UCCs), to safely and efficiently prioritise patients based on the severity of their conditions.<sup>7</sup>

Aiming to support triage nurses and enhance ED efficiency, kiosks collect demographic details as well as general (medical history, reason for attendance) and

complaint-specific medical information to aid accurate prioritisation, without replacing the triage nurse's role.<sup>8</sup> Designed to prevent overburdening the healthcare system, these digital triage interventions aim to optimise workflow and patient care while maintaining high levels of safety.<sup>9</sup>

Triage scales play a vital role in categorising patients and distinguishing between high-acuity and low-acuity cases.<sup>10</sup> Self-triage systems utilising triage scales, such as the Manchester Triage Score (MTS) system or comparable indices, can simplify the triage process by assisting clinicians in their clinical assessment.<sup>11 12</sup> If these systems demonstrate a high level of agreement with traditional clinical assessment methods, they have the potential to streamline the triage process. Through the collection of key clinical data up-front, self-check-in kiosk systems utilising priority scores have the potential to support earlier identification of critically ill patients, while also reducing the variability of triage assessment and highlighting those of lower priority or for whom urgent/emergency care is not the most appropriate healthcare setting.<sup>12</sup>

Additionally, the integration of these systems largely eliminates the duplication of data-gathering activities, such as personal and contact information and recording symptoms (history-taking). This enables clinicians to focus on delivering high-quality and safe patient care, while ensuring patients in critical conditions receive prompt attention.<sup>7</sup>

Implementation of digital triage in EDs and UCCs could generate time savings and operational efficiency.<sup>5-8 12-16</sup> Self-check-in kiosks can significantly streamline patient identification and queuing processes, with one study reporting a 14 min reduction in 'time to identification' (arrival to completion of check-in process) with self-check-in.<sup>5</sup> Small time savings in check-in time can lead to significant reductions in overall time-to-triage. In one simulation study, researchers estimated that a check-in time saving through a digital symptom-taking app in a UCC of 2.5 min per patient would decrease waiting time to triage of 26%, while a time saving of 5 min would be associated with a reduction in waiting time of 55%; the researchers described this as more efficient than adding an extra triage nurse.<sup>7</sup> Both ED overcrowding and patient mortality risks can be reduced through this reduction in waiting time.<sup>16</sup> An independent report in the USA also described survey evidence of patient experience improvements following the implementation of a check-in kiosk within EDs, with satisfaction scores increasing by 3%.<sup>14</sup> The potential of self-triage to reduce waiting times for critical conditions has been documented.<sup>10 12</sup>

However, studies have also reported instances of under-triaging (10.1%) and over-triaging (59%) with these systems.<sup>12</sup> The comparison of triage systems, particularly their diagnostic accuracy for high and low-acuity patients, is essential to optimise resource utilisation and patient safety.<sup>12</sup> The critical question

of whether these time-saving measures translate into improved overall patient outcomes and safety remains. While digital tools have a notable 97% usability rate and show promise in optimising patient flow and queuing,<sup>5 7</sup> further exploration is needed to understand their impact on the quality of care delivery, the working environment of healthcare staff and accuracy of triage.<sup>7 12 17</sup>

A preliminary examination of the current literature suggests that while previous systematic reviews<sup>10 18</sup> have offered valuable insights into digital triage within urgent care and emergency settings, significant gaps remain in our understanding, particularly concerning the implementation of kiosks in EDs. Most systematic reviews around tele-triage have primarily focused on digital triage or consultations delivered via telephone<sup>18</sup> or have evaluated the effectiveness of triage systems, such as MTS, in accurately identifying patients based on their varying levels of acuity.<sup>10</sup> However, there remains a need for a systematic review specifically exploring the implementation of digital check-in and triage kiosks.

Furthermore, existing research on digital self-check-in kiosks in EDs has predominantly focused on efficiency-related aspects, measuring waiting times, patient identification times and usability.<sup>5 8 12 16</sup> There is a scarcity of research exploring the direct impact of digital triage on workflow, triage time and the implications for the workload of healthcare staff. In the context of this systematic review, efficacy is defined as the ability of digital kiosks to perform their designated functions effectively in ED settings, including the efficiency and accuracy of patient check-in, triage and patient categorisation, without compromising patient safety.

Moreover, research has overlooked crucial considerations related to clinical outcomes influenced by the implementation of digital check-in and triage kiosks. Although research indicates no evidence of detrimental effects on patient safety, further comprehensive studies are necessary to strengthen the evidence base for safety considerations regarding acuity sensitivity and adverse events.<sup>17 19</sup>

This systematic review seeks to address these critical issues by conducting a rigorous examination of the existing literature, aiming to evaluate the efficacy and safety of self-service kiosk implementation within EDs. Additionally, recognising the potential impact of digital triage solutions on equity, the review will include a secondary outcome to explore variations in outcomes of efficacy and safety across patient groups, providing valuable insights into the potential benefits and challenges associated with the implementation of self-service kiosks in EDs.

### Research question

In adult patients and healthcare staff within an ED setting, how does the implementation of digital triage and check-in self-service kiosks compare to traditional triage methods in terms of efficacy, safety and equity?

## METHODS AND ANALYSIS

This systematic review will be carried out in line with Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines.<sup>20 21</sup>

### Eligibility criteria

The inclusion and exclusion criteria have been structured using the Population, Intervention, Comparator, Outcome and Study Designs framework outlined in table 1. All quantitative and mixed-method studies (with a significant quantitative component), regardless of research design or publication date, will be included to offer a comprehensive overview of the literature.

### Information sources and search strategy

Searches will be conducted across five databases: MEDLINE (Ovid), Web of Science, Scopus and Science Direct. The search strategy will include a range of keywords informed by a preliminary search of relevant literature and will use Boolean operators. The search terms will identify articles related to the safety and efficacy of digital triage within EDs. These terms will be adapted for each database, and where available, incorporate Medical Subject Headings (MeSH) terms. The list of search terms will be refined in consultation with the University of Liverpool's Medical

Liaison Librarian (see online supplemental appendix 1 for a draft search strategy).

### Data management and study selection process

Identified studies from the database searches will be imported into Mendeley, a reference management software. After the removal of duplicates within Mendeley, two independent reviewers will conduct screening of titles and abstracts. Full-text screening will then be carried out on studies identified as potentially relevant, to determine whether these studies meet the eligibility criteria. Reference lists of the selected articles will also be screened for papers that may have been missed by the initial database search but are still relevant. Cohen's kappa will then be calculated to check inter-rater reliability for screening. All disagreements will be resolved by discussion with a third researcher.

### Data extraction

Relevant data will be extracted by two independent researchers from eligible reports and collated into a standardised data extraction table. This will summarise the characteristics of the included studies, including author, study design, participant characteristics, date

	<b>Inclusion criteria</b>	<b>Exclusion criteria</b>
<b>Population</b>	Adult patients and healthcare staff within an emergency department setting.	Populations outside the scope of emergency department patients and staff. Paediatric patient populations will also be excluded.
<b>Intervention</b>	Implementation of self-service kiosks that act as a digital triage and check-in tool.	Do not specifically address the utilisation of kiosks for patient check-in, information collection, or triage in emergency departments.
<b>Comparator</b>	Interventions will be compared with traditional methods using triage nurses without the addition of a self-service kiosk.	Comparison of self-service kiosks with interventions other than traditional triage methods in emergency departments.
<b>Outcome</b>	<p>Studies reporting quantitative measures assessing the ability of digital kiosks to perform their designated functions, including patient check-in, triage and patient categorisation, without compromising patient safety.</p> <p>Measures for efficacy will include:</p> <ul style="list-style-type: none"> <li>▶ Workflow</li> <li>▶ Staff workload</li> <li>▶ Triage time</li> <li>▶ Overall operational efficiency</li> </ul> <p>Measures for safety and equity will include:</p> <ul style="list-style-type: none"> <li>▶ Accuracy of triage</li> <li>▶ Adverse events</li> <li>▶ Access and outcomes for diverse patient populations</li> </ul>	Studies that primarily focus on digital kiosks outside of these functions and on specific conditions unrelated to the emergency department setting will be excluded.
<b>Study Designs</b>	Quantitative studies and mixed-method studies with a significant quantitative component, including randomised controlled trials (RCTs), case-control studies, cohort studies and cross-sectional studies.	Studies that primarily report qualitative outcomes will be excluded, such as case reports, opinion pieces, trial protocols or interim reports.

PICO, Population, Intervention, Comparator, Outcome and Study Designs.

and duration of intervention, outcome measures and key findings relevant to the research aims.

### Study risk of bias and quality assessment

Two reviewers will employ the Cochrane Risk of Bias Tool to evaluate the quality of individual studies. This tool assesses key domains, including random sequence generation, blinding of participants and personnel, blinding of outcome assessment, allocation concealment, incomplete outcome data and selective reporting.<sup>22</sup> Studies skewed by biases will be acknowledged in the report or excluded. To examine publication bias, a funnel plot and Duval and Tweedie's trim and fill method will be used.<sup>23</sup> Disagreements will be resolved by a third reviewer. Subgroup analysis will be conducted to explore the impact of triage systems on these measures within both 'low-risk' and 'high-risk' bias groups. The evidence will be synthesised into a table and its strength will be assessed using the Grading of Recommendations Assessment, Development and Evaluation criteria.<sup>24</sup>

### Data synthesis methods

A narrative synthesis will be used to extract data on the clinical safety and efficacy of self-service kiosk implementation in EDs. Due to the heterogeneity of interventions and studies, conducting a meta-analysis will not be practical or possible. Consequently, a thematic analysis will be applied to the narrative synthesis of findings across studies.

### Outcomes

To assess the impact of digital triage in EDs, the primary outcome will examine the efficacy of digital triage and check-in kiosks, assessing aspects such as workflow, staff workload, triage time and overall operational efficiency.

As a secondary outcome, we will investigate whether the implementation of digital triage impacts patient safety, focusing on the accuracy of triage, clinical outcomes, adverse events and risk management. Additionally, we aim to explore potential equity implications, assessing variations in outcomes of efficacy and safety across diverse patient groups. It is important to note that the quantification of equity aspects may pose challenges, and the findings may be limited due to the exclusion of qualitative studies.

### Ethics and dissemination

This review is exempt from ethical approval because it will be analysing published studies containing non-identifiable data. The findings will be disseminated through peer-reviewed publications.

### Patient and public involvement

None.

## DISCUSSION

To date, there have been few systematic reviews investigating the efficacy and clinical safety implications of

implementing self-service kiosks in EDs. This review aims to bridge this knowledge gap by conducting a comprehensive analysis of both clinical safety and efficacy associated with self-service kiosk implementation. Our systematic approach seeks to provide an evidence-based evaluation of the impact of digital tools in EDs, considering their potential benefits while critically examining their potential effects on patient safety and healthcare workflow. This will provide policymakers and healthcare providers with the evidential basis for recommendations and decisions on the implementation of digital kiosk solutions in urgent and emergency care. Additionally, this review will provide insights for software developers, supporting the development of safer and more effective tools for patient check-in and prioritisation in these settings.

### Strengths and limitations

This systematic review will provide a thorough assessment of the literature related to the implementation of digital triage in emergency care settings, offering an examination of both efficacy and impact on clinical safety. Additionally, the review is based on a comprehensive search strategy and incorporates a diverse array of study types and designs.

There are limitations in this review. We expect to encounter substantial heterogeneity in the quality and design of studies included in this review. This heterogeneity may present challenges in synthesising the study results, making it difficult to draw meaningful conclusions from the data. Furthermore, the variation in study characteristics may complicate the generalisation of the findings to a broader population or healthcare setting. We also acknowledge the potential challenges in quantifying equity aspects and the limitation of not including qualitative studies that might provide more in-depth insights into equity concerns.

To address these potential challenges, we will employ a narrative synthesis approach alongside an assessment of the quality of the included studies using the Cochrane Risk of Bias Tool. By incorporating these approaches, we aim systematically to summarise and analyse the findings from studies with a range of research designs and varying quality levels. This combined approach will enable us to provide a comprehensive overview of the evidence while addressing the heterogeneity in study quality and design.

### Implications for policy and clinical practice

The findings from our systematic review will update the existing literature by illustrating the impact of self-service kiosk implementation in EDs. This information is highly relevant to clinical practice, with the potential to inform decision-making processes within healthcare institutions. Specifically, our findings may assist healthcare providers in their consideration of digital triage solutions in EDs as a viable strategy for optimising triage processes. This innovation may have the potential to advance initial patient assessments, enhance the overall patient experience and staff workload. Furthermore, by critically examining the



impact of self-service kiosk implementation on clinical safety, our review can inform the development of safety protocols and practices to minimise potential risks associated with digital triage.

### Implications for future research

We expect that our summary of the existing published evidence will identify further specific evidence gaps, paving the way for future research. By highlighting areas where further investigation is warranted, we aim to enhance the quality of care and streamline workflow within EDs. This will not only benefit the immediate healthcare setting but also contribute to the broader field of digital health technology implementation and its implications for efficacy and patient safety in emergency care.

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**Competing interests** BH and MH both worked for eConsult Health Ltd, provider of an online consultation platform for NHS primary, secondary and urgent and emergency care, at the time of initial design of the study; HS was employed as an intern by eConsult at that time. HS is also a medical student at the University of Liverpool and BH is an NHS GP and clinical academic at Imperial College London and MH is an NHS emergency medicine doctor. eConsult Health Ltd had no involvement in the design and development of the study or the writing, revision or editing of the manuscript, which was the work of all authors independently of the company. All other authors have no additional interests to disclose.

**Patient and public involvement** Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

**Patient consent for publication** Not applicable.

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