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SYSTEMATIC REVIEW

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Initiatives to reduce ambulance offload delays in emergency departments: a scoping review

Alice Svikers^{1*}, Lorna Martin¹, Liam Hemingway¹, Damien F. Gaumont^{2,3}, Niamh M. Cummins^{1,3,4,5} and Kelly-Ann Bowles¹

Abstract

Background Emergency departments (EDs) globally are experiencing increased pressure from crowding and ambulance offload delays (AODs), exacerbated by high hospital occupancy rates and insufficient bed capacity. Despite the significance of AODs, limited research exists on interventions to target such delays. This scoping review aims to identify evidence-based interventions to mitigate AODs and seeks to pinpoint gaps in existing literature, with a particular focus on the effectiveness of ED-based initiatives.

Methods Guided by the Joanna Briggs Institute methodology for scoping reviews, a systematic search was conducted across MEDLINE, AMED, Embase Classic+, Emcare, and CINAHL including articles to April 2025. All articles were screened in Covidence©. The inclusion criteria focused on initiatives within the ED setting, excluding studies on ambulance diversion, infrastructure changes and effective handover.

Results Sixteen articles were identified with interventions spanning the ED input, throughput, output concept. Some strategies showed potential in reducing both AODs and ED crowding, while others demonstrated effectiveness in only one of these outcomes. Ambulance offload zones were shown to reduce AODs, four-hour key performance standards reduced ED crowding, and early clinician assessment reduced both AODs and ED crowding.

Conclusion By mapping existing interventions and highlighting knowledge gaps, this scoping review provides a comprehensive overview of strategies to mitigate AODs. Front-loading patient care through multi-interventional methods can reduce AODs. The identified interventions hold promise, however, ongoing innovation, evaluation and exploration of system-wide approaches and advancements in healthcare technology are necessary to enhance ED efficiency. Future research should prioritise systemwide initiatives and the potential of emerging technologies to offer scalable solutions for AODs.

Keywords Ramping, Offload delay, Emergency medical service, Offload zone, Ambulance, Review

*Correspondence:

Alice Svikers
alice.svikers@monash.edu

¹Department of Paramedicine, Monash University, Frankston, Victoria, Australia

²Health Service Executive, National Ambulance Service, Limerick, Ireland

³Irish Paramedicine Education & Research Network (IPERN), National, Ireland

⁴School of Medicine, Sláinte Research and Education Alliance in General Practice, Primary Healthcare and Public Health, Faculty of Education and Health Sciences, University of Limerick, Limerick, Ireland

⁵Ageing Research Centre, Health Research Institute, University of Limerick, Limerick, Ireland



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Background

The escalating number of emergency department (ED) presentations worldwide has contributed to ambulance offload delays (AODs) and overcrowding [1]. Although this is an international problem, in the Irish setting, hospitals operate at high occupancy rates of 95% [2] which has contributed to a national ED crisis and persistent AODs [3]. In the United Kingdom (UK), over the last 25 years there has been a 20% reduction in hospital beds, whilst admission rates have remained largely unchanged [4]. In Australia, the recent Ambulance Ramping Report Card 2025 states that “the number of patients transferred on time has fallen dramatically since 2019–2020 where the total hours ramped (where recorded) has risen dramatically” [5]. A lack of ED staff, beds and resource availability all contribute to AODs [6]. It is known that AODs have repercussions on patient care and service delivery as delaying patient admissions to ED can compromise patient safety by delaying definitive care and time to treatment [7]. As these extended turnaround times reduce the pre-hospital resources available, the impact on ambulance response times is felt in the wider community [7].

A conceptual model of ED crowding was proposed more than 20 years ago (8) and continues to be discussed in the literature (Fig. 1) [9–11]. The initial stage, known as input, involves any condition, event or system characteristic that leads to the need for ED service. This can be through self-presentation or ambulance utilisation. The throughput phase focuses on factors that affect the patient length of stay in the ED. This may include aspects of assessment, observation and treatment. Finally, the output phase focuses on aspects that affect the ability to move the patient beyond the ED. This may include admission to relevant clinical areas, referral for ongoing management or discharge back into the community. Although it is possible that initiatives focusing on one aspect of this

model could improve ED crowding, these initiatives need to ensure that patient safety is not compromised.

Initiatives to reduce ED input, such as the rerouting of ambulances away from a busy ED to a less crowded ED (ambulance diversion) are well researched [12]. Due to conflicted findings and the potential for adverse consequences, many health services have opted to limit ambulance diversion [7]. Whilst the issues of AODs and ED crowding occur within the ED, both issues are strongly associated with the ability to move patients out of the ED. Diverting patients does not address issues occurring within the hospital [13]. The available literature suggests that factors influencing patient input to ED, such as diversion, are not effective at resolving AODs [7, 8, 13].

During a preliminary search of the literature pertaining to AODs, a 2017 scoping review by Kingswell et al. was identified [14]. In that review, the authors recommended consistent language and definitions to be used in future literature. Whilst Kingswell et al. [14] used the term ‘ramping’, the authors of this paper have opted to use the international term ‘ambulance offload delay’. As with the disparities in the terminology pertaining to AODs, there are also disparities with regard to the time measures of AODs. In Ireland, a handover time of more than 30 minutes is considered to be an AOD [15]. In comparison, target handover times vary between Australian states from 15 minutes to 40 minutes [5]. Further to this, different timepoints are used in the literature to ascertain the length of delay. For example, Burke et al. [16] used triage to first clinical location to determine the length of delay whilst Scharf et al. [17] used the time from when the ambulance arrived at the hospital destination to the time of transfer of care to the ED staff. For this review, the AOD time measure reported in each study was retained from the original research to accurately reflect the original context and outcomes.

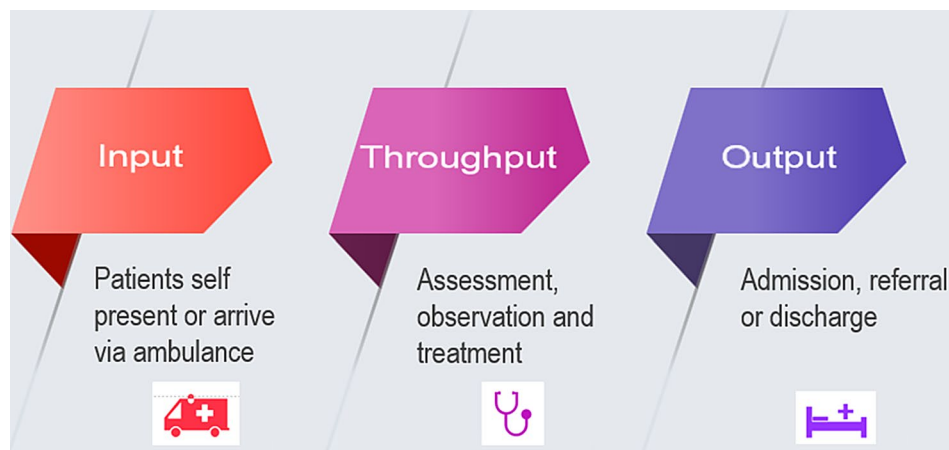


Fig. 1 The three stages of the input-throughput-output concept [8]

Since the COVID-19 pandemic, recent strategies have been implemented to address increased ED crowding [18]. Therefore, a need now exists to identify and analyse gaps in the literature pertaining to initiatives that have been introduced to address such delays, and therefore a scoping review methodology was chosen for this study. Due to the evolving global contexts, this scoping review aimed to identify and assess evidence-based initiatives to address AODs in the ED setting.

Methods

This scoping review was guided by the Joanna Briggs Institute (JBI) Methodology for Scoping Reviews and reported using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) Extension for Scoping Reviews checklist (Appendix 1) [19]. A protocol was developed and registered on the Open Science Framework (<http://osf.io/4s26w>) to provide a systematic framework for this review and was agreed upon by all authors. Scoping review methodology was chosen to systematically map the breadth and nature of the existing evidence, identify knowledge gaps, and provide a comprehensive overview of this heterogeneous and emerging body of literature [20].

Data sources and search strategy

A preliminary search was conducted of MEDLINE to identify a gold set of relevant articles. The text words contained in the title and abstracts of these articles and their associated index terms, were used to formulate a comprehensive search strategy based on the Population (P), Concept (C) and Context (C) framework (see Table 1). This was then reviewed by a university librarian. This strategy was applied across several databases,

including MEDLINE, AMED, Embase Classic+, Emcare, and CINAHL including outputs from inception to 24th April 2025 (see Appendix 2). The search strategy, including all identified key words and index terms, was tailored as necessary for each specific database. Key words and subject headings were combined with the “OR” Boolean operator within the components of the PCC and the “AND” Boolean operator across the components of the PCC.

All articles were uploaded into Covidence® [21], a web-based referencing and data extraction software tool, where duplicates were removed. All stages of the screening process were performed by two independent reviewers (including AS, DG, LH, LM), with conflicts being resolved by a third independent reviewer (either NC or KB). Initial screening saw all titles and abstracts assessed in line with the predetermined inclusion and exclusion criteria, and remaining articles then underwent a full text review against the same inclusion and exclusion criteria. A systematic search of Google Scholar, Trove and Informit was undertaken to identify grey literature using a modified version of the search strategy. Grey literature was included to capture emerging or unpublished evidence, ensuring a comprehensive overview of interventions relevant to AODs. The title and abstract of the first 200 results from each site were screened by one reviewer. Bidirectional citation searching was conducted on all included articles to identify any additional relevant work that may have been missed using Citation Chaser [22]. Every effort was made to retrieve full text versions of all included articles.

Inclusion and exclusion criteria

Studies were included if they incorporated initiatives addressing AODs in the ED. Whilst not based in a traditional ED setting, any research pertaining to ambulance interaction with a virtual ED (VED) was included due to its potential impact on ED presentations. The criteria for exclusion from the review were as follows: (i) scholarly piece with no research outcome, (ii) intervention or measures not focused on handover delay (iii) does not include ambulance/emergency medical services (EMS) to ED handover, (iv) research only focuses on a specific population group (e.g. stroke), (v) research only focuses on ambulance diversion, and (vi) not published in English.

Study quality assessment

Quality assessment is not a mandatory step in scoping reviews. However, it can help to estimate the reliability and validity of the articles included in the review and associated findings [23]. All included articles were assessed using the National Heart, Lung and Blood Institute’s (NHLBI) Study Quality Assessment tools [24]. The NHLBI tools were selected as they provide instruments

Table 1 Search strategy utilising the PCC framework

POPULATION	AND	CONCEPT	AND	CONTEXT
Ambulance/ _a		Off-load* _b		ED
Emergency Medical Technicians/		Offload*		Emergency department*
Paramedicine/		Overcrowd*		Hospital*
Emergency health service/		Over-crowd*		Emergency unit*
Paramedics/		Crowd*		
Paramed*		Handoff*		
EMS		Hand-off*		
EMT		Hand-over*		
Emergency medical technician*		Handover*		
Emergency medical service*		Conveyanc*		
Pre-hospital		Ramp*		
Prehospital				
Ambulance				

a. Subject heading =/; b. Truncation =*

tailored to different study methodologies and they are straightforward to apply, making them suitable for researchers with varying levels of experience. The selection of the appropriate NHLBI tools for each included article was determined based on its specific methodology. In line with the tools application instructions, all included articles were given a quality rating of “good”, “fair” or “poor” with no work excluded due to the quality rating [24]. To reduce the risk of bias, each individual article was assessed independently by two reviewers (AS and LH), and conflicts were resolved through discussion between the two reviewers. Due to the limited data available in the published work, conference abstracts did not undergo a quality assessment.

Synthesis of findings

Data was extracted by the primary reviewer (AS) using an extraction template with the following predetermined fields: (a) author and year; (b) geographical location; (c) initiative; (d) key findings; (e) sample size; (f) methodology; and (g) quality rating. A second reviewer (LH) independently verified the data, and any conflicts were resolved by a third independent reviewer (KB).

As pilot testing indicated that differing timepoints may be identified in the literature to establish the length of AODs, the concept of delay and the impact of the initiative being evaluated, remained in line with the author of the included work. A narrative synthesis of the included articles was completed, including a descriptive, qualitative content analysis of the literature. AOD initiatives were aligned to the patient journey through ED using the input-throughput-output model. Initiatives were deemed as positive, negative or mixed based on their overall effect on patient flow.

Results

The combined yield of the database searches was 5073 articles (Fig. 2). Following removal of the duplicates ($n=1822$), 3251 articles remained for further screening. During abstract and title screening, 3150 articles were deemed irrelevant based on the predetermined criteria. Of the remaining 101 articles, 20 reports could not be retrieved, leaving 81 articles for full-text review, of which 67 were excluded. The most common reasons for exclusion were ‘scholarly piece with no research outcome.’ This process resulted in 14 articles remaining for inclusion.

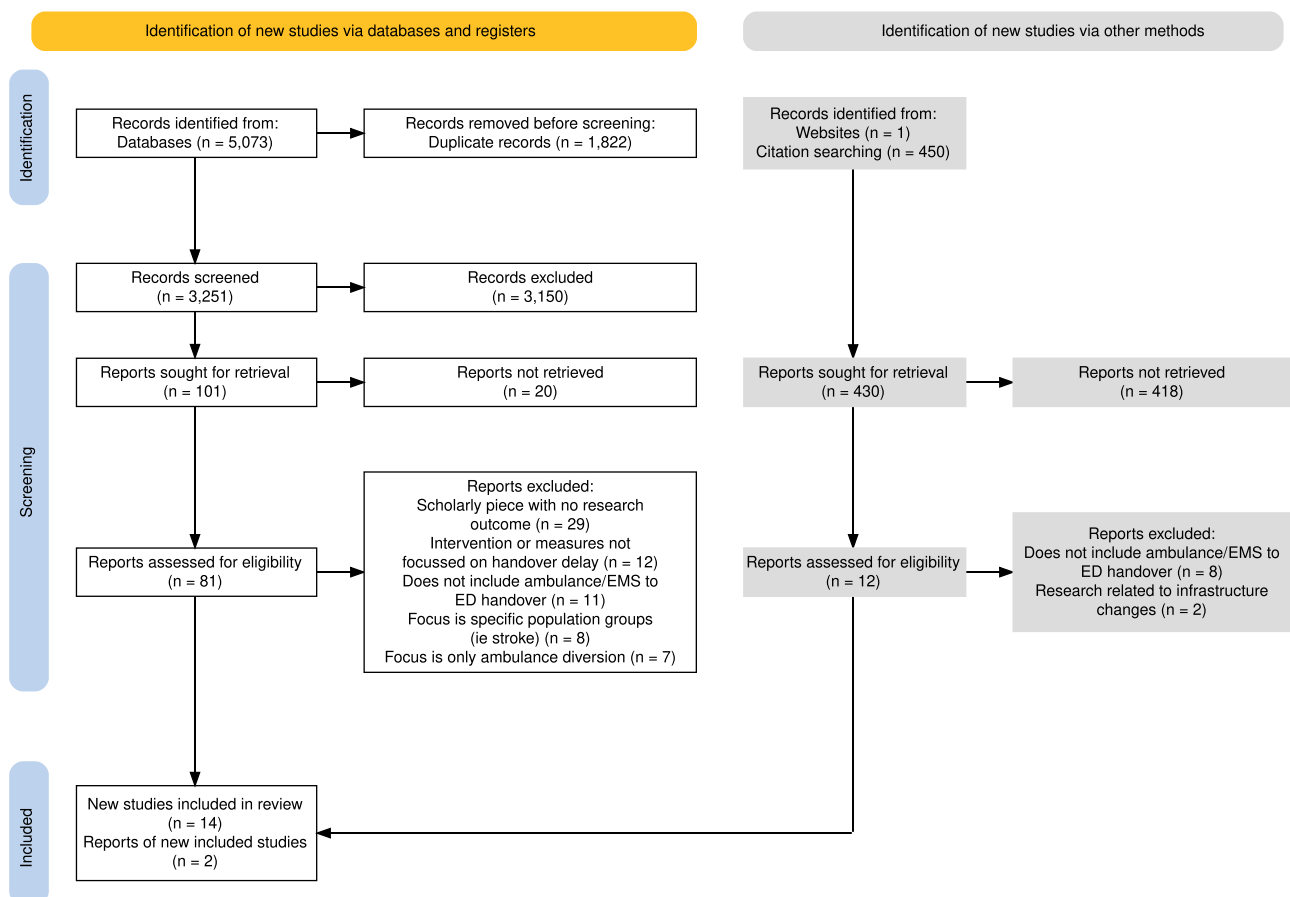


Fig. 2 PRISMA flowchart of included articles

Citation chasing identified 450 unique digital online identifiers (DOIs), 326 of which were backwards citations and 124 forward citations. After duplicates were removed 430 articles were screened by abstract and title, with 418 articles deemed irrelevant. Ten articles were excluded during full text screening leading to the inclusion of one additional article. Additionally, one piece of grey literature was deemed relevant and included. Therefore, including database searching, a total of 16 articles met the criteria for inclusion (Fig. 2).

Study characteristics

The included articles originate from Australia, Canada, the United States of America (USA) and the United Kingdom (UK). The majority of the articles were interventional studies that used a pre-post methodology. Sample sizes ranged from 500 to greater than 150,000 participants. The primary outcome for a majority of the papers was ambulance offload times or ED length of stay. A summary of the included articles is listed in Table 2.

Quality assessment findings

Based on NHLBI Study Quality Assessment Tools, five of the interventional articles were considered 'good', two were 'fair', four were 'poor' and one was 'not assessed'. The main reasons for 'fair' or 'poor' assessments were unclear research objectives and unaccounted confounding variables. Two observational articles were included, one was 'good' quality the other was a conference abstract and therefore not assessed. Two literature reviews were included, one was 'good' quality, the other was 'poor' quality. This was due to a lack of structure in question formulation and a potentially biased method. One qualitative article was included, but no quality assessment was performed as it was a conference abstract (see Table 2).

Initiatives

The identified initiatives were categorised using the input, throughput and output conceptual framework [8]. The results of this review found that, although research examining the input and throughput aspects of the conceptual framework were found, no research examined the effect of any AOD initiatives on the output aspect of the framework. Although some initiatives were deemed to have a positive effect on AODs (i.e. paramedics triage), other initiatives were conflicted in the literature with some positive evidence and some negative evidence (i.e. offload zones). Other initiatives (i.e. early clinician assessment) were deemed positive in some work and then other work deemed this initiative to have mixed results (Fig. 3). Paramedic triage was the least researched initiative investigated with only one article and early clinician assessment had the largest number of articles.

ED input initiatives – paramedic triage and offload zones (OZ)

The role of paramedics has not been well-researched among the initiatives to enhance efficiency in the ED. Paramedic streaming was trialled at an emergency and trauma centre in Melbourne, Australia to assess the similarities of the streaming decisions by paramedics and trained triage nurses [33]. It was found that paramedics can safely triage patients to streaming destinations as accurately as nurses [33]. Throughout the 14-month long study, the concordance between 500 paramedic and nursing decisions was 86.4% with paramedics tending to triage patients to a higher acuity streaming destination in non-concordant cases [33]. The authors suggested that while triage nurses would remain essential for patients who do not arrive by ambulance, paramedic streaming could reduce the burden on the triage nurses.

When assessing input, two articles focused on the implementation of dedicated waiting areas for patients transported via ambulance. These areas are referred to as offload zones (OZs) and reported conflicting outcomes although both studies were 'poor' quality [28, 29]. Whilst OZs were found to reduce AODs, results indicated that they can also increase the time to an ED bed for patients both within and outside of the OZ [28, 29]. Additionally, Li et al. [7] conducted a review of AODs literature and reported that staff have a reduced incentive to admit patients in an OZ to an ED bed, as priority is often given to patients in the waiting room, who are not yet under care, whereas patients in the OZ are already being managed by dedicated staff. Multiple variations of OZ models were identified in the review. Denning et al. [27] redesigned the physical layout of the OZ to include a seated waiting area for low acuity ambulance patients, and this redesign allowed for early clinician assessment in the OZ. Staffing models within OZs varied from study to study, with both nurses and paramedics featuring as offload clinicians.

ED throughput initiatives – early clinician assessment and key performance indicators

Whilst early clinician assessment is an initiative focused on patient throughput, articles focusing on early clinician assessment reported a variety of benefits to outcome measures for overall patient flow. For the purpose of this review, early clinician assessments is viewed as a throughput initiative as these occur within the ED. Eight articles focused on the effects of early clinician assessment [16, 17, 25–27, 30, 34, 36]. However, the implementation of this initiative differed between studies. This is consistent with the findings from Wells et al. [35] who found a lack of standardisation in initiatives to support timely handover from ambulance to ED. Three articles looked at the implementation of an ambulance offload clinician

Table 2 Study characteristics including lead author, year of publication, country, initiative, key findings, sample size, methodology and quality rating

Publication	Country	Initiative	Key Findings	Sample Size	Methodology	Quality Rating
Benabbas 2020 [25]	USA	Early Clinician Assessment	Decreased rates of LWBS and LWCA. Evidence weak for impact on LOS.	n = 12 articles	Systematic review	Good
Burke 2017 [16]	Australia	Early Clinician Assessment	LOS decreased, NEAT compliance increased and LWBS rates reduced.	n = 35,428	Pre-post intervention study	Good
Crilly 2020 [26]	Australia	Early Clinician Assessment	Reduction in time to medical assessment. Improved offload compliance. Decreased LOS. Cost effective.	n = 7010	Retrospective observational study	Fair
Denning 2018 [27]	UK	Early Clinician Assessment	Reduction in time across all areas and increased four-hour compliance.	Not reported	Pre-post intervention study	Not assessed
Elliot 2020 [28]	Canada	Offload Zones	Increased time to ED bed for patients in OZ. Reduced incentive to admit to ED bed.	n = 9496 on OZ n = 3078 off OZ	Quasi experimental design	Poor
Elliot 2023 [29]	Canada	Offload Zones	Reduced off load times. Increased time to ED bed for patients in OZ.	n = 18183	Quasi experimental design	Poor
Greaves 2017 [30]	Australia	Early Clinician Assessment	LOS decreased for patients staying over four hours only. Time to be seen decreased and LWBS rates reduced.	n = 21454	Retrospective observational study	Good
Li 2018 [7]	Canada	Summary Paper	Limited research, particularly operational research Health service wide issue.	n = 137	Literature review	Poor
Man 2020 [6]	Australia	4 Hour KPIs	Ambulance delays not improved by LOS improvements. ED LOS for ambulance arrivals reduced and access block decreased.	n = 1,573,064	Longitudinal cohort study	Fair
Momesso 2023 [31]	UK	4 Hour KPIs	Reduction in admissions. Increased LOS (larger increase for elderly participants). No clinically significant difference in AODs.	n = 102 227 pre n = 67 689 post	Pre, post retrospective observational study	Good
Ngo 2018 [32]	Australia	4 Hour KPIs	Reduced ED LOS and increased short stay admissions.	n = 1,946,418	Retrospective cohort study	Not assessed
Olaussen 2021 [33]	Australia	Triage	Paramedics can stream with high accuracy and low clinical risk.	n = 500	Prospective cohort study	Good
Scharf 2022 [17]	USA	Early Clinician Assessment	16% reduction in AOT. Higher reduction in more acute presentations.	n = 11,2104,898 (pre) n = 6312 (post)	Retrospective pre/post study	Good
Shetty 2012 [34]	Australia	Early Clinician Assessment	Reduced ED LOS. Reduction in off stretcher times and time to assessment. Slightly reduction in DNW rates.	n = 11408 pre n = 11845 post	Pre-post intervention study	Good
Wells 2015 [35]	UK	Summary Paper	Lack of consistency and evaluation across health services.	n = 11	Qualitative	Not assessed
Woodward 2019 [36]	Australia	Early Clinician Assessment	Reduced access block and ambulance offload delays. Small improvements in NEAT adherence. Time to be seen was unchanged. DNW rates reduced.	n = 2660 control n = 5078 intervention	Retrospective pre/post study	Poor

LWBS – left without being seen. LWCA – left without completing assessment. LOS – length of stay. NEAT – National Emergency Access Targets. ED – emergency department. OZ - offload zone. AODs – ambulance offload delays. AOT – ambulance offload time. DNW – did not wait. UK – United Kingdom. USA – United States of America

[17, 26, 30]. Two of these were staffed by nurses [26, 30] and one by an EMS clinician [17]. The programme staffed by EMS reduced AODs whilst the programme staffed by nurses reduced AODs, time to assessment and ED length of stay. Three articles looked at the implementation of an interprofessional model of care that included early senior physician assessment [16, 25, 34]. However, no studies looked at the impact of junior medical assessment.

A systematic review and meta-analysis recommended further research into the impact of resident physicians as triage liaisons [25]. Burke et al. [16] utilised an inter-professional team that assessed and treated patients for two hours before re-streaming them which resulted in decreased AODs and ED length of stay. Shetty et al. [34] added early streaming, point of care testing, treatments such as analgesia, antibiotics and intravenous fluids to

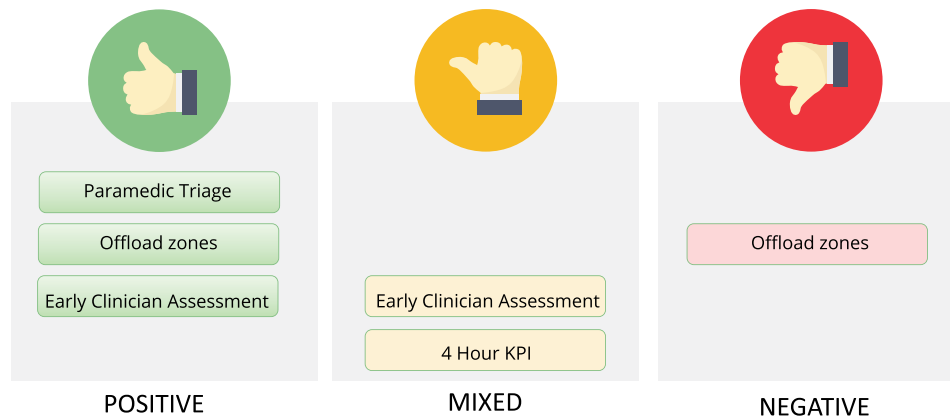


Fig. 3 The reported impact of initiatives investigated in the current literature

their early clinician assessment model. The care model resulted in decreased AODs, time to assessment and ED length of stay [34]. When assessing early clinician assessment alongside OZs, one study presented an initiative where patients arriving via ambulance were assessed and treated in a seated treatments zone to improve capacity [27]. This initiative resulted in reduced AODs, decreased time to treatment and improved four-hour compliance, demonstrating improvements across the patient journey.

The introduction or removal of four-hour key performance indicators (KPIs) was investigated in three of the included articles [6, 31, 32]. Four-hour KPIs require a high percentage of patients to be admitted, transferred or discharged within four hours of arriving at the ED [6, 32]. Two articles looked at the implementation of such standards [6, 32] while one article looked at the removal [31]. Conclusions on the effects of this intervention were mixed as shown in Fig. 3. One study showed a reduction in AODs with the introduction of the four-hour KPIs in only one of three jurisdictions. Man et al. [6] suggested that this reduction may be the result of other local initiatives to address AODs. Another article showed a reduction in ED length of stay but no reduction in AODs [32]. When four-hour admission standards were removed, ED length of stay increased but there was no difference to AODs [31]. One rationale for the mixed results is the varying quality of the studies. One study was not assessed due to being an abstract for an oral presentation, one was rated fair and another good (Table 2).

Discussion

Context of research evidence

This scoping review identified evidence-based interventions aimed at mitigating ambulance offload delays (AODs), with a particular focus on the effectiveness of initiatives implemented within the emergency department (ED). The initiatives identified primarily targeted the input and throughput phases of care, with no ED-based strategies addressing patient output. Evidence

supporting paramedic-led triage demonstrated a high level of concordance with nursing triage decisions, suggesting this model may safely challenge traditional ED intake processes. In contrast, the effectiveness of four-hour key performance indicators in reducing AODs was inconsistent across studies. Other ED-based initiatives showed differing patterns of effectiveness, with early clinician assessment models generally associated with improvements in AODs and ED flow, although the magnitude and specific outcomes varied between models. Overall, while several interventions show promise in reducing AODs, substantial gaps remain in the evidence base, particularly for emerging approaches such as telemedicine-enabled models of care.

Key findings

Multi-interventional models that front-load patient care demonstrate positive outcomes in reducing AODs and ED crowding. Models combining early senior medical assessment, point-of-care testing, treatment, and discharge were most effective [26, 27, 31, 34, 36]. Such models used combinations of early senior medical assessment, point of care testing, treatment and discharge. Whilst the simultaneous implementation of multiple interventions precludes the ability to discern individual contributions to the observed outcomes, the literature provides natural comparisons. A hospital-based liaison programme demonstrated a significant reduction in AODs during the COVID-19 pandemic [17]. However, when offload care provided by nurses was combined with testing and treatment the benefits also extend to decreasing time to treatment and length of stay [28, 30]. Similar benefits were seen with interprofessional models, that included early senior medical assessment, nursing care, testing and treatment [27, 34, 36]. Likewise, comparable efforts to front-load patient care have been shown to decrease length of stay and reduce the time to assessment for patients in a paediatric ED [37]. These findings align with

existing literature that suggests input factors contribute to ED crowding less than throughput factors [7, 8, 38].

OZs produce variable results depending on operational factors and patient flow. OZs allow patients to wait with designated OZ staff instead of with the paramedics who transported them, representing a more efficient use of paramedic time and enabling them to return to service. As the results of our review have shown, the effectiveness of OZs is inconclusive. When the OZ is quiet, AODs are reduced, aiding patient flow. However once the OZ becomes busy, the benefit is reduced [28]. This notion is supported by Carter et al. [39] who described the OZ as a dedicated space for low acuity patients arriving via ambulance where diagnostic workup and definitive treatment were not intended to commence. However, in the same research, real-life functioning of the OZ saw significant patient care commence in the OZ. Research suggests that once a patient starts receiving care in the OZ the incentive to admit them to a bed in ED is reduced with self-presenting patients in the waiting room being given priority for admission, further increasing the time to an ED bed for OZ patients [12, 28, 39]. With this model, the OZ functions as an extension of the ED, potentially further contributing to creating a backlog of ambulances [12, 39]. Denning et al. [27] challenged this theory by introducing a multi-interventional model that included clinical care in the OZ, addressing both input and throughput factors. By allowing low acuity ambulance patients to receive treatment in a seated OZ, time to treatment and AODs were reduced while four-hour KPI compliance improved. This redesign of the OZ increased its capacity and improved patient flow through all stages of the patient journey. Future research should acknowledge the significant operational variations between OZs and decisions made based on jurisdictional requirements and capacity.

KPIs affect ED crowding but do not consistently reduce AODs. In both the United Kingdom and Australia, it is stipulated that a percentage of patients should be admitted, discharged or transferred within four hours of arrival to ED [6, 31, 32]. Conflicting results were identified surrounding such KPIs. Notably, AODs were not reduced by either the implementation or the removal of a four-hour target [6, 31, 32]. Ngo et al. [32] found that while ED length of stay reduced after implementation of the four-hour rule, short stay admissions increased. Research by Man et al. [6] showed patients arriving to ED via ambulance had a shorter length of stay but this did not result in a reduction in AODs. Despite a reduction in ED crowding, AODs continued. This may suggest that staff are reluctant to start the four-hour 'clock' by accepting the patient handover. Additionally, moving patients from ED to short stay does not address underlying patient flow and hospital capacity issues, which has the potential to

continue to impact AODs. Similar to Woodward et al. [36] and Denning et al. [27], Asha et al. [40] used early senior medical assessment to successfully increase compliance with four-hour KPIs, supporting the implementation of multi-interventional approaches to reducing AODs. Asha et al. [40] suggested reviewing where inefficiencies are occurring within individual EDs and hospitals and targeting approaches appropriately, advocating for a system-wide approach to addressing AODs. Other research found that for many health services the need to comply to performance targets took priority over evaluation of initiatives [35]. Whilst ED crowding is reduced with KPIs, addressing underlying inefficiencies and ongoing evaluation is also required to address AODs.

Hospital-wide strategies can complement ED-focused interventions to reduce delays. The initiatives identified focused primarily on the input and throughput stages of the patient journey. While this may be indicative of the inclusion and exclusion criteria, it may also identify a lack of strategies that focus on patient output. Whilst this scoping review identified that initiatives which front-load patient care have the potential to improve patient input, throughput and output, hospital wide strategies have also been shown to reduce ED crowding. Bein et al. [41] found that a reduction in hospital occupancy had a significant impact on ED crowding when compared to strategies that solely address ED demand. Similarly, by spreading elective admissions evenly across the week a hospital in Boston was able to decrease both ambulance diversion and length of stay whilst seeing an increased number of patients [13].

Research assessing the impact of Virtual emergency departments (VEDs) on AODs were not found for this review but represent an innovative technological solution. The implementation of VEDs signifies a notable advancement in healthcare technology, emphasising the potential of innovative solutions to address challenges in pre-hospital care. A VED was set up in Melbourne, Australia during the COVID-19 pandemic. VEDs allow paramedics (and the general public) to consult with ED nurses and physicians. When utilised by paramedics, there was a 72.1% decreased likelihood of a physical ED presentation in the 72 hours following the consultation [42]. Beyond minimising unnecessary ED presentations, VEDs have the capacity to streamline patient care and enhance ED efficiency. Furthermore, the scalability of VEDs presents a global opportunity for healthcare providers to explore similar solutions. Technology similar to VEDs could be used to enhance initiatives such as paramedic triage on route to the ED, bypassing the need for a traditional triage process on arrival.

Implications for future research

AODs are a complex, multi-faceted issue with vast potential for future research. While the introduction or removal of the four-hour KPIs did not impact AODs, it did affect both emergency department (ED) crowding and length of stay. Further research is required to understand why these effects do not extend to AODs. Additionally, there is a significant lack of literature on system-wide approaches to reducing AODs. Research on the impact of virtual emergency departments (VEDs) and similar healthcare technology solutions should also be prioritised. Such research could provide valuable insights into AODs and improve efficiencies in the emergency healthcare.

Limitations

Despite AODs being recognised as being a global concern, the research emanates from four countries: Australia, Canada, the United States of America and the United Kingdom. This narrow geographic sphere may indicate a reduced significance of AODs in other healthcare systems or a bias towards countries actively involved in paramedicine research. Additionally, variability in pre-hospital care models between countries may influence AOD outcomes and introduces a potential source of bias when comparing findings across healthcare systems. Nations with well-established research capacities may consider seeking international collaborations to add diversity to the available research.

Conclusion

The escalating burden on EDs globally is reflected in rising AODs. There is a critical need for evidence-based interventions to improve patient care and efficiency across health care systems. Numerous initiatives have been implemented in attempts to address AODs however their effectiveness is variable, suggesting a need for ongoing innovation and evaluation. Multi-interventional methods that front-load patient care have been demonstrated to effectively address AODs and ED crowding. Looking ahead, system-wide approaches and advancements in healthcare technology, present exciting opportunities to transform ED efficiency.

Abbreviations

ED/s	Emergency Department/s
AOD/s	Ambulance offload delay/s
UK	United Kingdom
JBI	Johanna Briggs Institute
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
EMS	Emergency medical service/s
PCC	Population, Concept, Context
VED	Virtual emergency department
NHLBI	National Heart, Lung and Blood Institute
USA	United States of America
OZ	Offload zone/s

KPI Key performance indicators

Supplementary Information

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Supplementary material 1

Supplementary material 2

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Authors contributions

Securing of funding – NC and KAB; Conception and design – All authors; Acquisition of data – AS, LM, LH; Writing original draft – AS, LM, LH; Writing proofreading – All authors; Final approval of manuscript – All authors

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Data availability

All data generated or analysed during this study are included in this published article and its supplementary information files.

Declarations

Ethics approval and consent to participate

Not applicable due to this being a scoping review.

Consent for publication

Not applicable due to this being a scoping review.

Competing interests

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