A systematic review examining the impact of redirecting low-acuity patients seeking emergency department care: is the juice worth the squeeze?

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ABSTRACT

Objectives Diverting patients away from the emergency department (ED) has been proposed as a solution for mitigating overcrowding. This systematic review examined the impact of interventions designed to either bypass the ED or direct patients to other alternative care after ED presentation.

Methods Seven electronic databases and the grey literature were searched. Eligible studies included randomised/controlled trials or cohort studies that assessed the effectiveness of pre-hospital or ED-based diversion interventions. Two reviewers independently screened the studies for relevance, inclusion and risk of bias. Pooled statistics were calculated as relative risks (RR) with 95% confidence intervals (CI) using a random effects model.

Results Fifteen studies were included evaluating pre-hospital (n=11) or ED-based (n=4) diversion interventions. The quality of the studies ranged from moderate to low. Patients deemed suitable for diversion among the pre-hospital studies (n=3) ranged from 19.2% to 90.4% and from 19% to 36% in ED-based studies (n=4). Of the eligible patients, the proportion of patients diverted via ED-based diversion tended to be higher (median 85%; IQR 76–93%) compared with pre-hospital diversion (median 40%; IQR 24–57%). Overall, pre-hospital diversion did not decrease the proportion of patients transferred to the ED compared with standard care (RR 0.92; 95% CI 0.80 to 1.06). There was no significant decrease in subsequent ED utilisation among patients diverted via pre-hospital diversion compared with non-diverted patients (RR 1.09; 95% CI 0.99 to 1.21). Of the three pre-hospital studies completing a cost analysis, none found a significant difference in total healthcare costs between diverted and non-diverted patients.

Conclusion There was no conclusive evidence regarding the impact of diversion strategies on ED utilisation and subsequent healthcare utilisation. The overall quality of the research limited the ability of this review to draw definitive conclusions and more research is required prior to widespread implementation.

Key messages

What is already known on this subject

- Diverting low-acuity patients away from the emergency department has been proposed as a potential solution for mitigating overcrowding.
- The effects of diversion strategies on patients' healthcare utilisation and health outcomes are unknown.

What this study adds

- An extensive search of the literature identified 15 studies comparing either pre-hospital or emergency department-based diversion strategies to standard emergency care response.
- This review was unable to demonstrate conclusive evidence regarding the effectiveness of diversion strategies on emergency department use and subsequent healthcare utilisation.
- At this time there is insufficient evidence to recommend the implementation of diversion protocols as effective or safe strategies to address emergency department overcrowding.

INTRODUCTION

It is estimated that between 13.7% and 27.1% of all emergency department (ED) visits in the USA could be safely managed at alternative locations and result in an estimated cost savings of over $4 billion.[1] In the UK an estimated 17% of ED visits are considered 'inappropriate'[2] while, in Canada, it is estimated that one in five ED visits could be appropriately managed at a family physician's office.[3] Diversion of low-acuity patients from the ED to alternative sources of care may include pre-hospital diversion, in which patients are diverted prior to presenting to the ED (ie, dispatch-directed diversion, treat and release patients at the scene),[4] or ED-based diversion in which patients presenting to the ED are diverted to an alternative source of care.[5] Diverting low-acuity patients away from the ED to alternative sources of care is controversial due to its potential safety concerns.[6] The safety and effectiveness of ED diversion is unclear in part due to the fact that many studies use a single-group study design and do not compare diversion with standard care.[5]

The objective of this systematic review was to examine the effectiveness and safety of pre-hospital and ED-based diversion strategies on ED utilisation, non-ED healthcare utilisation and patient outcomes compared with standard emergency care responses.

METHODS

Protocol

A protocol was developed a priori and registered on the PROSPERO register (CRD42016033613). Reporting adheres to the PRISMA guidelines.

Search strategies

The search strategies used language (English) and year (1990 to January 2016) restrictions and were applied in seven electronic bibliographic databases: Medline, Embase, Cochrane Library, PsycINFO, CINAHL, Social Services Abstracts and ProQuest Dissertations and Theses Global (see supplementary file 1 for the Medline search strategy). To identify unpublished studies and studies in progress, Google Scholar, Health Services Research Projects in Progress, Health Services/Sciences Research Resources, National Centre for Biotechnology Information Bookshelf and ClinicalTrials.gov were searched. In addition, a SCOPUS forward search of all included studies was completed (2017). Reference lists of included studies and conference proceedings from the Society for Academic Emergency Medicine (2008–2017) and the Canadian Association of Emergency Medicine (2008–2017) were also reviewed.

Study selection

Two reviewers (AS, SWK) independently screened the search results to identify potentially relevant studies; at least one reviewer independently reviewed the full text of potentially relevant studies to confirm their inclusion. Reviewer discrepancies on study inclusion were discussed and resolved via third party abjudication (ASN, BHR). Randomised/controlled clinical trials and controlled cohort studies (retrospective or prospective) were eligible for inclusion. Case–control or before/after studies were not eligible for inclusion, as recommended by the Cochrane Effective Practice and Organisation of Care Group (EPOC) in this review[7] due to difficulties attributing causation in these studies. To be included in the review, studies of these designs had to (1) include patients seeking ED care; (2) assess the effect of any diversion strategy designed to either bypass the ED to an alternative source of care (pre-hospital diversion) or direct patients to a non-ED setting after presentation to an ED (ED-based diversion); and (3) compare the diversion with standard emergency care. What was considered to be standard emergency care could vary among studies and intervention types, which could include, but was not limited to, patient transport to the ED, standard emergency medical service (EMS) assessment, or attending and being assessed by an ED physician. Strategies to divert ambulances away from EDs while the patient was being transported (ambulance diversion) were excluded, as this review attempted to examine the effectiveness of diversion strategies other than those that temporarily closed the ED to incoming ambulance transport. No studies were excluded on the basis of patient age or presenting medical conditions.

The primary outcome of interest was the number of visits to the ED, including initial and subsequent visits. For the purposes of this review, subsequent ED visits referred to additional unplanned return ED visits following the index visit. Secondary outcomes of interest were: patient diversion to, or utilisation of, non-ED-based settings for care (eg, assistance at the scene of the emergency, referral to primary care); hospitalisation; serious adverse events (eg, death, ICU admission); and patient quality of life (eg, health status). Additional outcomes of interest—namely, the percentage of patients considered eligible for diversion, the percentage of patients diverted, compliance with the diversion strategy, patient refusal of diversion and cost-effectiveness—were extracted a posteriori.

Quality assessment

Randomised/controlled clinical trials were assessed using the Cochrane Collaboration Risk of Bias Assessment tool[8] while the quality of cohort studies was assessed using the Newcastle–Ottawa Scale.[9] Two reviewers (AS, SWK) independently assessed each study's methodological quality. Disagreements that could not be resolved by discussion were adjudicated via a third party (ASN).

Fidelity of the diversion strategy and its implementation were assessed by one reviewer (SWK) and checked by another (AS) based on the five criteria from the Treatment Fidelity Assessment Grid including: fidelity to theory/literature, provider training, treatment implementation, treatment receipt and treatment enactment.[10]

Data extraction

Data from the included studies were extracted using standardised forms by one reviewer (AS) and verified for accuracy and completeness by a second (SWK). Discrepancies were resolved by discussion between the reviewers and any disagreements were resolved via third party adjudication (ASN, BHR). In the case of unclear or unreported information in the original studies, primary authors were contacted. For studies assessing diversion strategies across various settings, only the data from arms receiving a pre-ED or ED-based intervention were extracted.

Data analysis

Unadjusted pooled statistical analyses were performed using Review Manager (RevMan Version 5.3; Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014). For each reported outcome in which pooling was possible (in which two or more studies reported a similar outcome measure), studies were subgrouped based on whether the study employed a pre-hospital or ED-based diversion strategy. Only studies with the same study design were included in the pooled subgroup analysis. Given that the majority of the included studies were randomised controlled trials (RCTs) or controlled clinical trials, all of the pooled meta-analysis consisted of randomised or controlled clinical trials, with outcomes for the observational cohort studies being reported separately. For dichotomous variables, individual and pooled statistics were calculated as unadjusted relative risks (RR) with 95% confidence intervals (CI) using a random effects model. Heterogeneity was tested using the I^2 statistic with I^2 values of 25%, 50% and 75% representing low, moderate and high degrees of heterogeneity, respectively.[8] In some cases, studies calculated and reported adjusted odds ratios (aOR), adjusted risk difference (aRD) and adjusted relative risks (aRR), which were recorded. Published group differences in the proportion of events using frequencies with corresponding P values or mean differences (MDs) with 95% CIs were reported. Pre-planned subgroup analyses for age and illness/disorder/presenting complaint were not possible given the heterogeneity among included studies. A post-hoc decision was made after the review protocol was registered to group study outcomes according to whether the studies employed pre-hospital or ED-based diversion strategies so that outcome reporting was clinically meaningful. No sensitivity analysis was planned.

RESULTS

Study selection and characteristics of included studies

Figure 1 describes the flow of studies through the selection process. The search strategies identified 7891 studies for screening. The full text of 192 studies identified as potentially relevant were reviewed, 15 of which were included in the review. The 15 studies consisted of 10 clinical trials[11–20] and five observational cohort studies (prospective[21–23] and retrospective[24 25]).

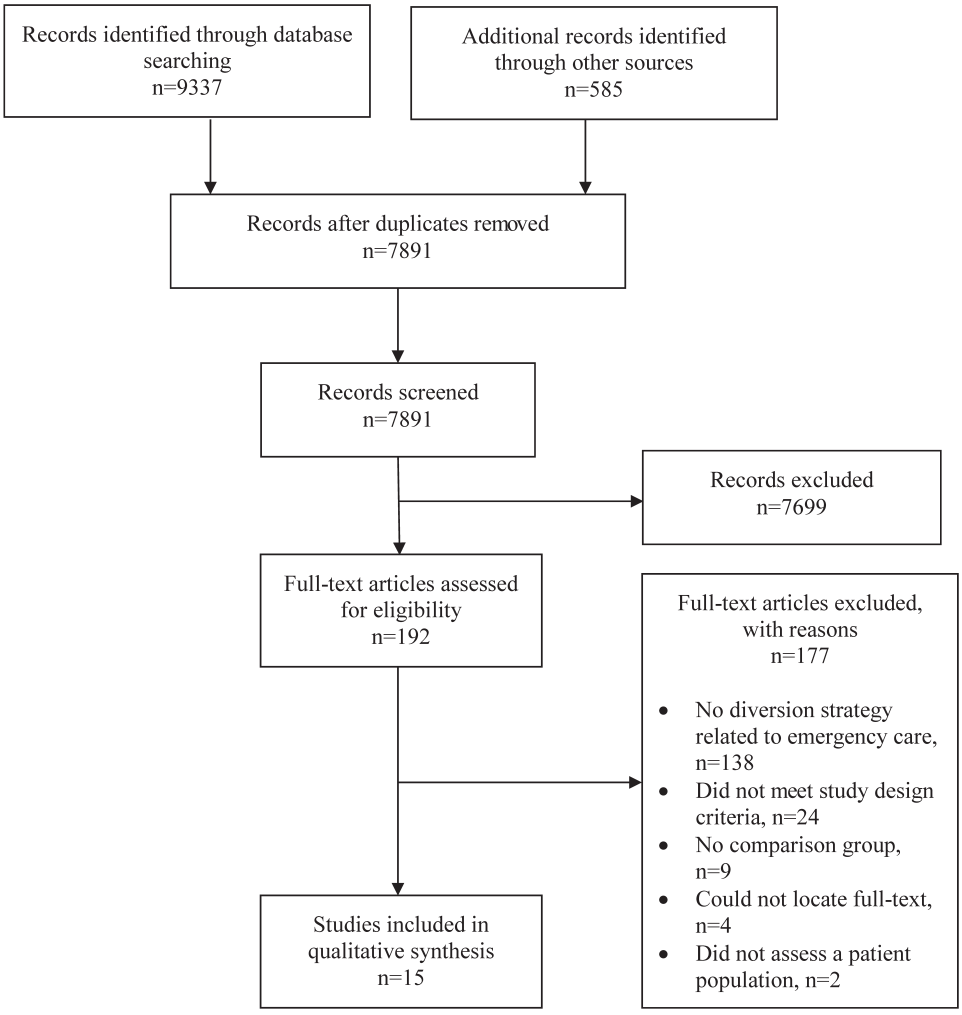

Figure 1 Literature search flow diagram.

Three studies (Mason *et al* (2007),[11] Mason *et al* (2008)[15] and Dixon *et al* (2009)[14]) assessing a 'treat and release' protocol reported different outcomes for the same dataset of patients; for the purposes of this review, Mason *et al* (2007)[11] was reported as the main report while Mason *et al* (2008)[15] and Dixon *et al* (2009)[14] were considered supplemental reports. The methodological quality and fidelity assessment was not completed for studies considered supplemental reports.[14 15] Mason *et al* (2012) assessed the effectiveness of emergency care practitioners across five various healthcare services and, as such, only the data from the ambulance service group (pre-hospital diversion) were extracted for the purposes of this review.[19] The characteristics of the included studies are shown in table 1. All of the studies reported enrolling patients with low-acuity or 'non-serious' medical conditions; however, the criterion for judging patient acuity was not well reported and what was considered a low-acuity medical condition varied among studies. Snooks *et al* (2014) and Snooks *et al* (2017) specifically reported enrolling elderly patients calling for an ambulance due to a fall.[12 13] The control groups for all of the studies consisted of low-acuity patients, except the study by Washington *et al*[21] in which the control group consisted of patients with abdominal pain, musculoskeletal or respiratory infection complaints who were deemed unsafe for diversion. In five of the pre-hospital studies it was noted that some patients in the control group were not transported to the ED due to patients refusing transport to the ED, paramedics treating patients on-scene, or paramedics transporting patients to other non-ED healthcare settings.[12 13 16 18 22]

Methodological quality of the included studies

Overall, the clinical trials were assessed as having either an unclear[17] or high risk of bias[11–13 16 18–20] (see online supplementary file 2). High risk of bias in the studies was based on inadequate allocation concealment,[18] non-blinding of staff and participants,[12 13 19 20] selective outcome reporting[11 16 18] and lack of compliance with the study protocol among the participating staff.[16] The cohort studies were assessed as being of moderate[21–25] quality with the primary methodological limitation being a lack of details on comparability between the cohorts (see online supplementary file 3).[21–23 25]

Diversion characteristics

Eleven studies evaluated pre-hospital diversion, of which seven studies were clinical trials[11–16 18] and four studies were controlled observational cohort studies.[19 22 24 25] In the study by Dale *et al*,[18] all emergency calls for non-serious conditions were passed on to a nurse/paramedic following ambulance dispatch who, with

Table 1 Overview of study and intervention characteristics and implementation outcomes associated with diversion implementation

				Study participants			Implementation				
Author ID Study Design/ methodological quality	**Diversion intervention (I) features**	**Comparison (C) features**	**Geographic setting and scope**	**Sample size**	**Target age (sample mean or median)**	**Target complaints**	**% participants eligible**	**% participants diverted ***	**% participant adherence**	**% participants refused diversion**	**Initial ED attendance**
Pre-hospital diversion											
Dale (2003)[18] Controlled clinical trial High risk of bias	A nurse or paramedic assessed 999 calls as to whether or not to dispatch ambulance. If caller triaged as not requiring an ambulance, they were offered advice and asked whether they still wished an ambulance to attend. Ambulance was not cancelled without consent of caller	Usual ambulance response with no telephone assessment/advice	England Ambulance service sites covering the whole of Greater London, Birmingham, Coventry, the Black Country and South Staffordshire; total population of about 10 million	I: 635 C: 611	All ages (I: mean 44 years, C: mean 49 years)	Non-serious concerns	51.9% (n=330/635)	36.1% (n=119/330)	NR	62.4% (n=206/330)	RR†0.76 (95% CI 0.69 to 0.84)
Krumperman (2015)[24] Observational cohort Moderate quality	Low-acuity calls to a 911 call centre were diverted to a nurse call centre. A nurse used a protocol to provide advice and/or refer caller to their PCP or urgent care centre	Paramedics decided whether concern could be treated at the scene and/or referred to a PCP	USA. Ambulance service sites covering a rural and urban area; exact setting and population not reported	I: 216 C: 374	All ages (NR)	Low-acuity concerns	NR	NR	95% (n=205/216)	NR	NR
Mason (2007)[11] Mason (2008)[15] Dixon (2009)[14] Cluster RCT High risk of bias	Paramedic practitioner travelled with the ambulance and was trained to assess and treat low-acuity complaints at the scene	Usual ambulance response, including EMS crew assessment and transport to the ED	England Ambulance service sites covering Sheffield.	I: 1549 C: 1469	≥60 years (mean 83 years)	Minor injury or illness	NR	Mason 2007[11] 70.4% (n=1090/1549)	NR	NR	NR
Mason (2012)[19] Quasi-experimental trial Low quality	Emergency care physicians working as a single responder to ambulance service 999 calls who assesses the patients and either discharges them at the scene or refers to the most appropriate care practitioner	Standard paramedic/ technician ambulance responding to ambulance service 999 calls	England & Scotland All NHS trusts employing emergency care physicians in England and Scotland were invited to participate. 'Control' trust sites that did not employ emergency care physicians but were within the same or in a neighbouring county and offered the same service configurations as intervention trusts were selected to participate	I: 593 C: 514	Unclear (I: mean 69 years, C: mean 63 years)	Not specified. Emergency or urgent complaints that were eligible to be seen by the emergency care physicians	NR	43.3% (n=257/593)	NR	NR	NR
Ross (2013)[25] Observational cohort Moderate quality	Paramedic evaluation and transport to a detoxification facility with limited medical care on a 24-hour, 7-day per week basis	Transport to the ED	USA El Paso County ambulance service agencies covering the greater Colorado Springs metropolitan area; total population of about 370,000	I: 138 C: 580	>18 years (I: median 46 years, C: median 43 years)‡	Alcohol intoxication without any significant acute illnesses or injuries	19.2% (n=138/718)	92% (n=127/138)	NR	NR	NR
Snooks (2004)[16] Cluster RCT High risk of bias	Ambulance crews transported patients who met specific criteria to a minor injury unit	Transport to the ED	England Five ambulance stations in the London and Surrey ambulance services	I: 409 C: 425	Unclear§ (NR)	Minor injuries, but not illnesses	NR	10% (n=41/409)	NR	NR	RR†0.96 (95% CI 0.89 to 1.04)
Snooks (2004)[22] Observational cohort Moderate quality	Ambulance crews used protocols to treat patients who fell within a list of dispatch criteria at home (treat and release)	Transport to the ED	England Two ambulance stations in West London	I: 251 C: 537	Unclear (I: mean 54 years, C: mean 47 years)	Non-serious injuries or illnesses	NR	37.1% (n=93/251)	40.2% (n=101/251)	NR	NR

Continued

Table 1 Continued

Author ID Study Design/ methodological quality	Diversion intervention (I) features	Comparison (C) features	Geographic setting and scope	Study participants: Sample size	Study participants: Target age (sample mean or median)	Study participants: Target complaints	Implementation: % participants eligible	Implementation: % participants diverted *	Implementation: % participant adherence	Implementation: % participants refused diversion	Implementation: Initial ED attendance
Snooks (2014)[13] Cluster RCT High risk of bias	Computerised clinical decision support tool for paramedics to use to decide whether to take patients who had fallen to the ED or leave at home with referral to a community-based falls service	Transport to the ED	Wales Recruited patients from two UK study sites. Paramedics were eligible to participate in the trial if they worked at any of 13 ambulance stations with a falls referral pathway in place	I: 436 C: 343	>65 years (I: median 83 years, C: median 82 years)	Falls	NR	42% (n=183/436)	NR	NR	RR† 0.94 (95% CI 0.82 to 1.09)
Snooks (2017)[12] Cluster RCT High risk of bias	Clinical protocol used by paramedics for the care of older people who have fallen to assess and refer them to a community-based falls service	Transport to the ED	England and Wales Three ambulance services in England and Wales in which a falls prevention service was available, but no services in place for paramedics to make referrals from the scene of emergency service call attendances	I: 2420 C: 2284	>65 years (I: mean 82.54 years, C: mean 82.14 years)	Falls	90.4% (n=2161/2391)	8.4% (n=204/2420)	NR	NR	RR† 1.04 (95% CI 1.00 to 1.09) aOR¶ 1.08 (95% CI 0.96 to 1.22)
ED-based diversion											
Doran (2013)[20] Quasi-experimental trial Low quality	Research specialist and triage nurse identified eligible patients to be escorted from the ED waiting room to the primary care clinic	Usual ED care	USA Adult academic ED serving 100 000 patients treated yearly	I: 662 C: 191	≥23 years (I: mean 47.3 years, control: mean 46.3 years)	Any	25.7% (n=1404/5462)	85% (n=563/662)	93.4% (n=526/563)	15% (n=99/662)	NR
Ellbrant (2015)[23] Observational cohort Moderate quality	PED nurse determined whether patients would be sent home, referred for other ED care or admitted	PED physician who determined whether patients would be sent home, referred for other ED care or admitted	Sweden Academic hospital in Malmö, Sweden, serving approximately 400 000 urban people	I: 344 C: 713	0–17 years (NR)	Any	32.5% (n=344/1057)	84.3% (n=290/344)	NR	NR	NR
Washington (2002)[17] RCT Unclear risk of bias	Triage nurses used standardised criteria to identify patients who would be safe for deferred care at a non-emergency setting at a later date	Usual ED care	USA Academic level 1 hospital in Los Angeles County, California, with 91 000 visits annually	I: 75 C: 81	>18 years (I: mean 41 years , C: mean 42 years)	Abdominal pain, musculoskeletal symptoms, or respiratory infection	35.7% (n=421/1176)	100% (n=75/75)	96% (n=71/74)	48% (n=143/299)	NR
Washington (2000)[21] Observational cohort Moderate quality			USA Tertiary care medical centre in Los Angeles, California, with approximately 30 000 unscheduled walk-in visits	I: 226 C: 961	>18 years (mean 53 years of those patients screened n = 1187)		19% (n=226/1187)	68.1% (n=154/226)	90.3% (n=139/154)	NR	NR

*Those participants assigned to receive diversion and were actually diverted from the ED.
†Unadjusted RR.
‡Median age reported.
§The study did include paediatric patients <5 years of age, but an upper age limit was not specified.
¶As well as indicators for group, site and their interaction, covariates adjusted for included age and its square, distance to ED, recruitment point, seasonality, biological sex and whether or not the index call was made out of GP hours.
a, adjusted; ED, emergency department; GP, general practitioner; NA, not available; NR, not reported; PCP, primary care physician; PED, paediatric emergency department; RCT, randomised controlled trial; RR, relative risk.

the aid of computerised decision support, assessed, triaged and provided advice to the patients, including asking patients triaged and not requiring an ambulance whether they still preferred ambulance transport. In the study by Krumperman *et al*,[24] low-severity calls were diverted from emergency call centres to nurse call centres, in which nurses used evidence-based protocols to provide patients' instructions and referrals to primary care providers or urgent care.[24] Nine studies assessed the impact of an EMS-based strategy: five studies assessed a 'treat and release' strategy in which paramedics assessed and treated low-acuity patients at the scene[11 14 15 19 22] while four studies assessed strategies in which ambulance crews either diverted low-acuity patients to a minor injury unit (MIU),[16] a community-based falls service,[12 13] or transported intoxicated patients to a detoxification centre.[25]

Four studies evaluated ED-based diversion, of which one study was a randomised controlled trial[17] and three studies were controlled observational cohorts.[20 21 23] Ellbrant *et al*[23] examined the role of an experienced paediatric nurse to identify patients suitable for referral to primary care or discharge home, while Washington *et al*[21] and Washington *et al*[17] examined deferral by a triage nurse to a next-day primary care appointment. Doran *et al* diverted patients via a research specialist and a triage nurse identifying eligible ED patients to be diverted to a same-day appointment at a primary care clinic.[20]

Diversion fidelity

Steps to ensure fidelity of the diversion strategy and its implementation were lacking in the studies (see online supplementary files 4 and 5). Six studies[12 17 18 21 22 25] reported the use of literature and/or experts to develop the strategy; however, the strategies were not necessarily underpinned by theoretical propositions. Eight studies described how personnel in diversion strategy delivery were trained.[11 12 15 17 18 21 22 25] Five studies used protocols/guidelines to standardise intervention delivery and receipt[12 16 17 21 22]; this approach was lacking or unclear in other studies. The majority of studies reported steps taken to ensure treatment enactment although approaches varied.[12 16–18 21 22 24]

Effects of diversion

ED attendance

There was considerable variation among the studies assessing pre-hospital diversion with regard to the proportion of patients deemed safe and appropriate for diversion, as well as the proportion of patients who were actually diverted away from the ED (table 1). Dale *et al* assessed a prehospital diversion intervention consisting of telephone-based assessment and advice from nurses/paramedics and found that 52% (n=330/635) of emergency callers with non-serious conditions did not require ambulance transport, of which 63% of callers triaged as not needing an ambulance were transported and attended the ED while only 18% (n=58/325) of these patients accepted the ambulance diversion.[18] Snooks *et al* reported that, among those patients allocated to be diverted, only 10% (n=41/409) were actually diverted from the ED (table 1).[16] The study by Ross *et al*, which diverted intoxicated patients to a detoxification facility, found that 19% (n=138/718) of intoxicated patients were deemed safe for diversion, of which 92% (127/138) were successfully diverted away from the ED with the remaining 11 patients being denied entry into the facility.[25] Mason *et al* reported that 43% (n=257/593) of patients seeking ambulance transport were discharged following consultation with an emergency care physician, while another 14% (n=85/593) were referred by the emergency care physician to a primary care provider.[19] A pooled meta-analysis of four pre-hospital diversion studies[12 13 16 18] did not identify a difference in the number of patients conveyed to the ED between diverted and non-diverted patients (RR 0.92; 95% CI 0.80 to 1.06); however, significant heterogeneity was identified (I^2=86%) (see figure 2). Overall, the median proportion of eligible patients diverted via pre-hospital based strategies was 40% (IQR 24–57%).

There was similar variation with regard to the proportion of patients deemed appropriate for diversion among studies assessing ED-based diversion strategies (table 1). In their study in 2000, Washington *et al* reported that 19% (n=226/1187) of ED patients were safe for deferral to a next-day primary care appointment, of which 68.1% were diverted.[21] In their 2002 study, Washington *et al* found that 36% (n=421/1176) of patients were considered safe for next-day appointments and that almost half (48%; n=143/229) of ED patients refused the offer of diversion.[17] Ellbrant *et al* reported that nurses identified 33% (n=344/1057) of paediatric patients who did not require ED physician assessment.[23] Of those children who did not require assessment by a physician and were seen by a paediatric nurse, 51% were discharged home, 33% were referred for primary care and 16% were referred for other ED care.[23] Finally, Doran *et al* reported that 85% (n=563/662) of patients accepted diversion when offered compared with 15% (n=99/662) of patients who refused and received care in the ED.[20] Overall, the median proportion of eligible patients diverted via ED-based diversion strategies was 85% (IQR 76–93%).

Subsequent ED attendance

Overall, there is insufficient evidence to conclude whether or not ED diversion alters patients' subsequent ED utilisation (table 2). A meta-analysis of three pre-hospital studies[12 13 15] failed to identify a significant difference in subsequent ED visits among diverted and non-diverted patients within 1 month following the index call (RR 1.09; 95% CI 0.99 to 1.21) (see online supplementary file 6). Heterogeneity was low (I^2=0%).

The effect of ED-based diversion on subsequent visits to the ED was only reported in two studies. Ellbrant *et al* reported that 7.6% of patients either referred to primary care or discharged home by a paediatric nurse returned to the ED with similar symptoms within 72 hours.[23] Doran *et al* reported no significant differences in subsequent ED visits within 2 weeks of the

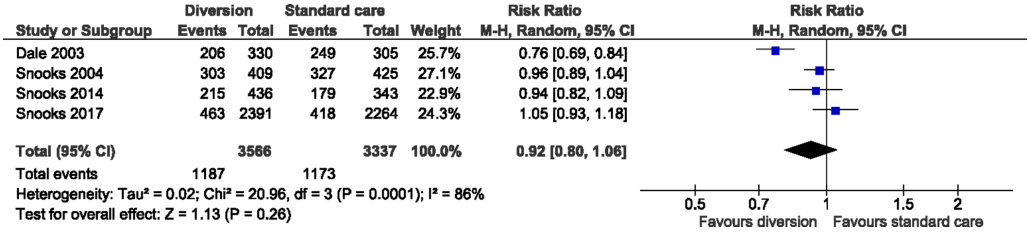

Figure 2 The impact of pre-hospital diversion on initial ED use.

Table 2 Impact of diversion on subsequent ED visits

Study	Intervention	Comparison	Outcome	Result
Pre-hospital diversion				
Mason (2007)[11]	Paramedic practitioner+ambulance crew to assess and treat at the scene	Transport to ED	ED attendance (0–28 days)*	RR†0.72 (95% CI 0.69 to 0.75)
Mason (2008)[15]			Subsequent ED attendance within 7 days	RR†1.25 (95% CI 1.01 to 1.53)
			Callers with ED attendance who returned to the ED for a similar clinical condition	75.2% vs 72.1% (P=0.64)
Ross (2013)[25]	Paramedic evaluation and transport to a detoxification facility	Transport to ED	ED attendance by diverted patients for an adverse event within 12 hours of detoxification facility arrival	2.9% vs NR
Snooks (2004)[16]	Ambulance crew transport to a minor injury unit	Transport to ED	Patients subsequently transferred to ED from the minor injury unit	9%§ vs NR
Snooks (2014)[13]	Ambulance crew referral to community-based falls service	Transport to ED	Subsequent ED visits within 1 month of the index call	RR†1.10 (95% CI 0.74 to 1.62)
Snooks (2017)[12]	Ambulance crew referral to community-based falls service	Transport to ED	Subsequent ED visits within 1 month of the index call. Subsequent ED visits within 6 months of the index call	RR†0.93 (95% CI 0.83 to 1.05) aOR‡1.07 (95% CI 0.92 to 1.24) RR†1.00 (95% CI 0.94 to 1.07) aOR‡1.00 (95% CI 0.89 to 1.12)
ED-based diversion				
Doran (2013)[20]	Deferred to on-site primary care clinic	Usual ED care	Subsequent treat and release ED visits within 2 weeks of the index visit	RR†0.55 (95% CI 0.29 to 1.06)
Ellbrant (2015)[23]	PED nurse	PED physician	Diverted patients who returned to the ED within 72 hours with similar symptoms	7.6% vs NR

*Includes ED visits at time of diversion (initial ED visits) and within 28 days follow-up (subsequent visits).
†Unadjusted RR.
‡As well as indicators for group, site and their interaction, covariates adjusted for included age and its square, distance to ED, recruitment point, seasonality, sex and whether or not the index call was made out of GP hours.
§This value includes patients from both the intervention and comparison groups who were transported to the minor injury unit.
a, adjusted; ED, emergency department; NA, not applicable; NR, not reported; PED, paediatric emergency department; RR, relative risk.

index visit (RR 0.55; 95% CI 0.29 to 1.06) between diverted and non-diverted patients.[20]

Use of other healthcare services

Two studies compared subsequent unplanned non-ED healthcare utilisation between diverted and standard ED care patients (table 3, online supplementary file 7). Mason *et al* reported that elderly patients undergoing a 'treat and release' protocol were more likely to subsequently visit other healthcare services (RR 1.21; 95% CI 1.06 to 1.38).[11] Snooks *et al* reported that diverted patients were less likely to make a further emergency service call at 1 month after the index call compared with standard care patients (aOR 0.82; 95% CI 0.71 to 0.94); however, no significant difference was found in the proportion of patients making emergency calls at 6 months after the index call (aOR 0.90; 95% CI 0.80 to 1.01).[12]

Three ED-based diversion strategies reported on subsequent healthcare utilisation (table 3).[17 20 21] The study by Washington *et al* in 2002, which assessed next-day referrals to a primary care clinic, reported no differences in the number of patients making subsequent visits to the ED or primary care clinic (RR 1.09; 95% CI 0.23 to 5.26).[17] Washington *et al* in 2000[21] and 2002[17] reported that 90.3% (n=139/154)[21] and 95.9% (n=71/74)[17] of patients deferred to a next-day appointment at a primary care clinic attended the appointment, respectively. Doran *et al* reported that patients deferred to a same-day appointment at an on-site primary care clinic were more likely to attend follow-up primary care appointments than patients receiving standard ED care (aRD 11.3; 95% CI 6.0 to 16.5).[20]

Hospitalisation

Three clinical trials assessing pre-hospital diversion compared the frequency of subsequent hospitalisations within 1 month of the post-index call between diverted and standard care patients and found no differences (RR 0.95; 95% CI 0.82 to 1.09)[11–13] (table 4, online supplementary file 8). Heterogeneity was moderate (I^2=68%). Similarly, one study reported no differences in subsequent hospitalisations between diverted and non-diverted patients 1 month after the post-index call (RR 1.01; 95% CI 0.95 to 1.07).[12]

The effectiveness of ED-based diversion strategies to reduce subsequent hospitalisations was not frequently reported (table 4). In their 2000 study, Washington *et al* reported a significant decrease in subsequent hospitalisations among patients diverted to a follow-up primary care appointment compared with patients attending the ED (RR 0.15; 95% CI 0.05 to 0.48).

Patient outcomes

Four pre-hospital diversion studies reported mortality,[11–13 25] with no differences in mortality within 1 month (RR 0.98; 95% CI 0.82 to 1.18; I^2=0%; n=4 studies) or 6 months (RR 1.03; 95% CI 0.91 to 1.16; n=1 study) after the index visit (see online supplementary files 9 and 10). Two studies assessing ED-based diversion strategies reported on mortality. In 2000 Washington *et al* reported no difference in mortality within 1 month between diverted and non-diverted patients (RR 0.39; 95% CI 0.02 to 6.94)[21] while in 2002 they reported no deaths among the participating patients.[17] No differences in the risk of worsening health status[11] or quality of life[12–14 17] were reported among the included studies (see online supplementary file 10).

Cost-effectiveness

Three studies assessing pre-hospital diversion strategies reported on the cost-effectiveness of diversion strategies for all patients allocated to the intervention and control groups. In 2014 Snooks *et al* reported no differences in the total cost of subsequent

Table 3 Impact of diversion on non-ED healthcare utilisation

Study	Intervention	Comparison	Outcome	Result
Pre-hospital diversion				
Dale (2003)[18]	Telephone-based assessment and advice from nurse or paramedic	Usual ambulance response	Diverted callers assisted at the scene	13.2% vs NR
			Diverted callers seen by GP within 7 days	8.8% vs NR
			Diverted callers who engaged in self-care within 7 days	4.4% vs NR
Krumperman (2015)[24]	Telephone-based advice and/or referral to a PCP/urgent care centre	Ambulance treated patient at scene and/or referred to a PCP or urgent care centre	Percentage of patients who followed instructions	95% vs 82%
Mason (2007)[11]	Paramedic practitioner+ambulance crew to assess and treat at the scene	Transport to ED	Subsequent unplanned contact with secondary care† within 28 days	RR* 1.21 (95% CI 1.06 to 1.38)
Snooks (2004)[16]	Ambulance crew transport to a minor injury unit	Transport to ED	Transport to minor injury unit	RR* 1.15 (95% CI 0.75 to 1.76)
Snooks (2004)[22]	Treat at home	Transport to ED	Left at the scene	RR* 1.02 (95% CI 0.84 to 1.24)
Snooks (2017)[12]	Ambulance crew referral to community-based falls service	Transport to ED	Patients with further emergency service call at 1 month post index call	RR* 0.85 (95% CI 0.76 to 0.95) aOR† 0.82 (95% CI 0.71 to 1.01)
			Patients with further emergency service call at 6 months post index call	RR* 0.97 (95% CI 0.91 to 1.03) aOR† 0.90 (95% CI 0.80 to 1.01)
ED-based diversion				
Doran (2013)[20]	Deferred to on-site primary care clinic	Usual ED care	Primary care follow-up	aRD‡ 11.3 (95% CI 6.0 to 16.5)
Washington (2002)[17]	Deferred care at a non-emergency setting at a later date	Usual ED care	Subsequently sought care from physician within 7 days±	RR* 1.09 (95% CI 0.23 to 5.26)
			Diverted patients adherence to deferred care appointment	95.9% vs NA
Washington (2000)[21]			Diverted patients adherence to deferred care appointment	90.3% vs NA

*Unadjusted RR.
†As well as indicators for group, site, and their interaction, covariates adjusted for included age and its square, distance to ED, recruitment point, seasonality, sex and whether or not the index call was made out of GP hours.
‡Treatment effect adjusted for age, sex, race, education, insurance, previous PCC and ED/UC visits and self-reported health.
§Adjusted for ambulance site, age, sex and distance to nearest ED, date of recruitment and whether call was out of hours.
a, adjusted; ED, emergency department; NA, not applicable; NR, not reported; PED, paediatric emergency department; RD, risk difference; RR, relative risk.

healthcare utilisation (MD £247; 95% CI −£247 to £741) among diverted and standard care patients.[13] In a follow-up study in 2017, Snooks *et al* reported similar total costs of healthcare resource use at 1 month (adjusted mean change £190.24; 95% CI −£13.83 to £394.31) or 6 months (adjusted mean change £24.20; 95% CI −£468.01 to £516.40) between elderly patients diverted to a fall service compared with patients transported to the ED.[12] Dixon *et al* reported a decreased cost associated with reduced ED attendance (MD −£32; 95% CI −£38 to −£26) among diverted patients; however, no significant differences were found with regard to the total costs associated with same day or subsequent healthcare utilisation (MD −£140; 95% CI −£694 to £415), which included same-day and subsequent ED presentations and inpatient costs.[14] No studies assessing ED-based diversion strategies examined cost-effectiveness.

DISCUSSION

An extensive search of seven electronic databases and the grey literature was conducted to identify all of the available comparative studies assessing the effectiveness of ED diversion strategies. Overall, the evidence to support or refute the effectiveness and safety of this practice in the EMS setting is lacking. The percentage of patients reported to be suitable for diversion was low,[17 18 20 21 23 25] with some studies reporting fewer than half of the suitable patients diverted away from the ED,[12 13 16 18 19 22] and many patients refusing diversion.[17 18 20] Given the potential costs (eg, additional staffing, training, updating, surveillance) associated with implementing pre-hospital and ED-based diversion strategies, evidence supporting its value in the EMS system is limited.[14]

Overall, there also appears to be limited evidence that ED diversion alters subsequent healthcare utilisation. Among the studies that could be pooled, no differences in subsequent ED utilisation were found. No change in subsequent hospitalisations was found among four studies assessing pre-hospital diversion strategies, while the study by Washington in 2000,[21] which assessed ED-based diversion, reported a significant decrease in subsequent hospitalisations. The effect of diversion strategies on subsequent non-ED-based health services was inconsistent. With respect to the safety of pre-hospital and ED-based diversion, ED diversion appears to be no less safe or harmful for low-acuity patients than if they were treated in the ED.[11–14 17 21 25]

While the current state of evidence is mixed, the results of this review provide several key directions for future diversion-based research. First, there is a need for additional high-quality RCTs assessing the effectiveness of ED diversion strategies. Of the 15 included studies, eight were clinical trials,[11–18] none of which were assessed as having a low risk of bias. Second, this review identified inconsistency in outcome reporting across studies, limiting this review to broad interpretations of outcome trends and in some cases precluded studies from inclusion into a meta-analysis. Studies frequently did not report important clinical and patient outcomes such as

Table 4 Hospitalisation following diversion and standard emergency care

Study	Intervention	Comparison	Outcome	Result
Pre-hospital diversion				
Dale (2003)[18]	Telephone-based assessment and advice from nurse or paramedic	Usual ambulance response	Hospitalisation within 7 days	12.1% vs NR
Mason (2007)[11]	Paramedic practitioner+ambulance crew to assess and treat at the scene	Transport to ED	Hospitalisation within 28 days	RR* 0.87 (95% CI 0.81 to 0.94)
Ross (2013)[25]	Paramedic evaluation and transport to a detoxification facility	Transport to ED	Hospitalisation within 2 years	RR* 0.16 (95% CI 0.02 to 1.06)
Snooks (2004)[22]	Treat at home	Transport to ED	Hospitalisation within 14 days among patients treated at home	RR* 0.87 (95% CI 0.32 to 2.41)
Snooks (2014)[13]	Ambulance crew referral to community-based falls service	Transport to ED	Patients with initial hospital stay at index call	RR* 0.62 (95% CI 0.52 to 0.73)
			Patients with subsequent hospital stay by 1 month post index call	RR* 0.99 (95% CI 0.69 to 1.42)
Snooks (2017)[12]	Ambulance crew referral to community-based falls service	Transport to ED	Proportion of patients with further emergency admission at 1 month post-index call	RR* 1.03 (95% CI 0.92 to 1.15) aOR† 1.04 (95% CI 0.90 to 1.20)
			Proportion of patients with further emergency admission at 6 months post-index call	RR* 1.01 (95% CI 0.95 to 1.07) aOR† 1.00 (95% CI 0.89 to 1.13)
ED-based diversion				
Doran (2013)[20]	Deferred to on-site primary care clinic	Usual ED care	Admitted at index visit	RR* 0.19 (95% CI 0.05 to 0.67)
Ellbrant (2015)[23]	PED nurse	PED physician	Diverted patients hospitalised following ED return with 72 hours	0.87% vs NR
Washington (2002)[17]	Deferred care at a non-emergency setting at a later date	Usual ED care	Hospitalisation within 7 days	0% vs 0%
Washington (2000)[21]			Hospitalisation within 7 days	RR* 0.15 (95% CI 0.05 to 0.48)

*Unadjusted RR.
†As well as indicators for group, site and their interaction, covariates adjusted for included age and its square, distance to ED, recruitment point, seasonality, sex and whether or not the index call was made out of GP hours.
a, adjusted; ED, emergency department; NR, not reported; PED, paediatric emergency department; RR, relative risk.

subsequent ED utilisation and mortality, which are important to understand the effectiveness and safety of diversion strategies. Moving forward, it is important for future research to report these outcomes to improve the validity of author claims and develop a consensus among the research and clinical communities on the effectiveness and safety of diversion strategies. Third, despite all of the studies employing a control group, several studies did not report outcomes for standard care patients. Future studies must examine the differences between standard ED care and diversion strategies to better understand the safety and effectiveness of diversion strategies. Fourth, the effectiveness of the ED diversion strategies across many of the studies is unknown due to the limited reporting of the number of patients suitable for diversion, as well as compliance with or refusal to accept diversion. In addition, despite the clear resource implications for implementing ED diversion strategies, including training and hiring additional staff, costs of implementing the diversion strategies were infrequently reported.[12–14] If a minority of patients are deemed suitable for diversion and an even smaller proportion of patients accept diversion recommendations, the costs of implementing diversion strategies may not be justified. Fifth, there were significant differences in type and approach to diversion across the included studies. Future studies should build on the results of this review to develop and compare similar diversion strategies to standard approaches to mature the evidence base. Should promising diversion strategies emerge from this evidence base, there may be an opportunity for comparative effectiveness studies involving differing diversion approaches. Finally, the criteria to determine patient suitability for ED diversion varied among studies; some studies did not report the criteria for how a patient was judged as presenting with a low-acuity/non-serious medical condition. It is possible that only a select set of medical conditions are suitable for ED diversion, but this could not be assessed in this review due to inadequate reporting. Future studies that are designed to conduct subgroup analyses between patient ages and condition types would provide valuable data to the field.

Study limitations

The methodological quality of the included studies necessitates caution when interpreting the results of this review. As discussed previously, the quality of the studies included in this review ranged from moderate to low. The results of this review are undermined by the limited quality and comprehensiveness of outcome reporting among the studies regarding healthcare utilisation and patient safety. Second, based on the assessment of intervention fidelity, it is possible that the implementation of the ED diversion strategies was suboptimal. It is important that future research ensures that the diversion strategies are implemented as originally intended in order to determine the true effectiveness of diversion strategies. Third, this review did not include assessments of all available diversion strategies. For example, a Canadian e-health study assessed the effectiveness of a computer-based algorithm to assist triage nurses to identify ED patients suitable for diversion to a medical clinic; however, this study did not include a comparison group[26] and, as such, could not be included in this review. A final limitation of this review relates to the risk of publication and selection bias. While steps were taken to limit these issues (eg, a comprehensive search of the published and unpublished literature;

independent reviewers and adjudication), it is possible that studies could have been missed due to the fact that some limitations based on English language and date of publication were imposed. Finally, despite the extensive search, the use of these interventions is probably underestimated by this review. We suspect many studies assessing diversion interventions may not have been found because formal reporting of their evaluations has not been completed and, when completed organisationally, publication is not a priority.

CONCLUSIONS

This review was unable to identify clear evidence regarding the impact of pre-hospital and ED-based diversion on subsequent healthcare utilisation. There was considerable variation in the proportion of patients deemed suitable for diversion across the studies. From the available evidence, there does not appear to be clear increased personal health risks to patients who receive diversion versus standard emergency care responses. At this time, there is insufficient evidence to recommend the implementation of ED diversion strategies to address ED overcrowding. Additional comparative effectiveness studies are urgently needed to examine the 'reach' of ED diversion strategies, including patient compliance and refusal with diversion, as well as a better understanding of the costs, changes in healthcare utilisation and patient outcomes prior to widespread implementation of any diversion strategies.

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REFERENCES

1 Weinick RM, Burns RM, Mehrotra A. Many emergency department visits could be managed at urgent care centers and retail clinics. *Health Aff* 2010;29:1630–6.
2 Martin A, Martin C, Martin PB, *et al*. 'Inappropriate' attendance at an accident and emergency department by adults registered in local general practices: how is it related to their use of primary care? *J Health Serv Res Policy* 2002;7:160–5.
3 Canadian Institute for Health Information. Sources of potentially avoidable emergency department visits. *Healthc Q* 2014;17:82.
4 Smith WR, Culley L, Plorde M, *et al*. Emergency medical services telephone referral program: an alternative approach to nonurgent 911 calls. *Prehosp Emerg Care* 2001;5:174–80.
5 Derlet RW, Kinser D, Ray L, *et al*. Prospective identification and triage of nonemergency patients out of an emergency department: a 5-year study. *Ann Emerg Med* 1995;25:215–23.
6 Vertesi L. Does the Canadian Emergency Department Triage and Acuity Scale identify non-urgent patients who can be triaged away from the emergency department? *CJEM* 2004;6:337–42.
7 EPOC resources for review authors. 2015. http://epoc.cochrane.org/epoc-specific-resources-review-authors/ (accessed 2 May 2016).
8 Higgins JPT, Green S. Cochrane handbook for systematic reviews of interventions version 5.1.0 (updated March 2011). The Cochrane Collaboration. www.cochrane-handbook.org.
9 Wells G, Shea B, O'Connell D, *et al*. *The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomised studies in meta-analyses*. Ottawa, ON: Ottawa Hospital Research Institute, 2011. (accessed 15 Feb 2016).
10 Borrelli B, Sepinwall D, Ernst D, *et al*. A new tool to assess treatment fidelity and evaluation of treatment fidelity across 10 years of health behavior research. *J Consult Clin Psychol* 2005;73:852–60.
11 Mason S, Knowles E, Colwell B, *et al*. Effectiveness of paramedic practitioners in attending 999 calls from elderly people in the community: cluster randomised controlled trial. *BMJ* 2007;335:919.
12 Snooks HA, Anthony R, Chatters R, *et al*. Support and Assessment for Fall Emergency Referrals (SAFER) 2: a cluster randomised trial and systematic review of clinical effectiveness and cost-effectiveness of new protocols for emergency ambulance paramedics to assess older people following a fall with referral to community-based care when appropriate. *Health Technol Assess* 2017;21:1–218.
13 Snooks HA, Carter B, Dale J, *et al*. Support and Assessment for Fall Emergency Referrals (SAFER 1): cluster randomised trial of computerised clinical decision support for paramedics. *PLoS One* 2014;9:e106436.
14 Dixon S, Mason S, Knowles E, *et al*. Is it cost effective to introduce paramedic practitioners for older people to the ambulance service? Results of a cluster randomised controlled trial. *Emerg Med J* 2009;26:446–51.
15 Mason S, Knowles E, Freeman J, *et al*. Safety of paramedics with extended skills. *Acad Emerg Med* 2008;15:607–12.
16 Snooks H, Foster T, Nicholl J. Results of an evaluation of the effectiveness of triage and direct transportation to minor injuries units by ambulance crews. *Emerg Med J* 2004;21:105–11.
17 Washington DL, Stevens CD, Shekelle PG, *et al*. Next-day care for emergency department users with nonacute conditions. A randomized, controlled trial. *Ann Intern Med* 2002;137:707–14.
18 Dale J, Higgins J, Williams S, *et al*. Computer assisted assessment and advice for "non-serious" 999 ambulance service callers: the potential impact on ambulance despatch. *Emerg Med J* 2003;20:178–83.
19 Mason S, O'Keeffe C, Knowles E, *et al*. A pragmatic quasi-experimental multi-site community intervention trial evaluating the impact of emergency care practitioners in different UK health settings on patient pathways (NEECaP Trial). *Emerg Med J* 2012;29:47–53.
20 Doran KM, Colucci AC, Hessler RA, *et al*. An intervention connecting low-acuity emergency department patients with primary care: effect on future primary care linkage. *Ann Emerg Med* 2013;61:312–21.
21 Washington DL, Stevens CD, Shekelle PG, *et al*. Safely directing patients to appropriate levels of care: guideline-driven triage in the emergency service. *Ann Emerg Med* 2000;36:15–22.
22 Snooks H, Kearsley N, Dale J, *et al*. Towards primary care for non-serious 999 callers: results of a controlled study of "Treat and Refer" protocols for ambulance crews. *Qual Saf Health Care* 2004;13:435–43.
23 Ellbrant J, Åkeson J, Åkeson PK. Pediatric emergency department management benefits from appropriate early redirection of nonurgent visits. *Pediatr Emerg Care* 2015;31:95-100.
24 Krumperman K, Weiss S, Fullerton L. Two types of prehospital systems interventions that triage low-acuity patients to alternative sites of care. *South Med J* 2015;108:381–6.
25 Ross DW, Schullek JR, Homan MB. EMS triage and transport of intoxicated individuals to a detoxification facility instead of an emergency department. *Ann Emerg Med* 2013;61:175–84.
26 Morris J, Daoust R, Cournoyer A, *et al*. LO65: safety and satisfaction of a new program redirecting low-acuity emergency department patients to medical clinic: a prospective cohort study. *CJEM* 2018;20:S29–S30.