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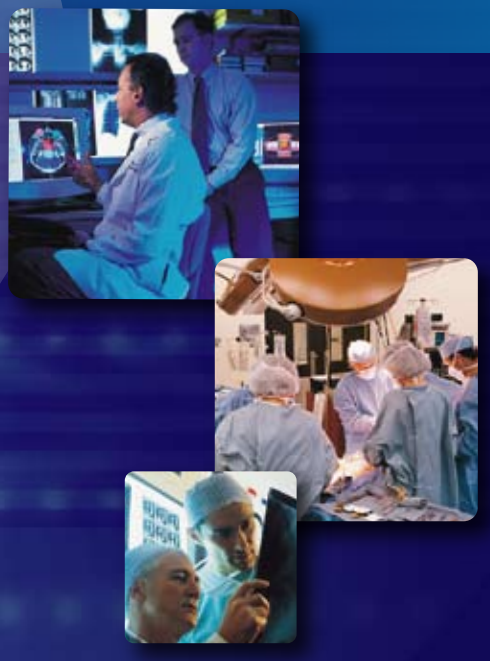
Interventions to Reduce Overcrowding in Emergency Departments



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This report and the French version entitled *Évaluer les interventions destinées à réduire le surpeuplement de l'urgence* are available on CADTH's web site.

This is the last in a series of four CADTH reports on emergency department (ED) overcrowding in Canada. The series looks at measures of ED overcrowding, and examines databases and information systems to monitor the issue. It also examines the frequency, determinants, and impacts of overcrowding. Finally, the series explores interventions used to reduce ED overcrowding and reviews which interventions are successful. An overview report on the series is available.

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Interventions to Reduce Overcrowding in Emergency Departments

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May 2006

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Sandra Blitz contributed to the data processing and data synthesis plan; produced data summaries, statistical analysis, and interpretation; participated in drafting and revising the report; and approved the final version of the manuscript.

Carol Friesen designed and executed literature searches, and wrote the associated appendix on literature searching.

Grant Innes contributed to the conception of the study design and acquisition of data, revised the report for intellectual content, and approved the final version of the manuscript.

Philip Yoon contributed to the conception of the study design and acquisition of data, revised the report for intellectual content, and approved the final version of the manuscript.

Gil Curry contributed to the conception of the study design and acquisition of data, revised the report for intellectual content, and approved the final version of the manuscript.

Brian Holroyd contributed to the conception of the study design and acquisition of data, revised the report for intellectual content, and approved the final version of the manuscript.

Brian H. Rowe is the guarantor of the study. He contributed to the conception and design of the review; led the protocol development, acquisition of data, and design of data analysis and interpretation; co-wrote the report; revised it critically for intellectual content; and approved the final version of the manuscript.

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Conflicts of Interest

Brian H. Rowe, Kenneth Bond, Maria B. Ospina, Sandra Blitz, Carol Friesen and all other authors disclosed no conflicts of interest. Gil Curry and Brian Holroyd are Emergency Department directors in Alberta; however, their ED overcrowding interventions were not cited in this report. Grant Innes and Philip Yoon had several abstracts/manuscripts considered for inclusion in this report; however, they were not involved in the search and selection of the included studies and did not comment specifically on the content of their articles.

REPORT *IN BRIEF*

May 2006

Interventions to Reduce Overcrowding in Emergency Departments

Issue and Methods

Emergency department (ED) overcrowding can be defined as a situation where the demand for emergency services exceeds the ability to provide care in a reasonable amount of time. There is a need to understand the relative effectiveness of available interventions to reduce ED overcrowding. A systematic review of published literature on ED overcrowding was conducted, supplemented by a survey of 243 Canadian hospital ED directors (158 respondents; 65% response rate).

Implications for Decision Making

- **Fast track systems can reduce overcrowding.** Fast tracking patients with minor injuries or illnesses can reduce ED length of stay, waiting time, and the number of patients who leave without being seen. Establishing these systems, however, has resource and space implications. Sixty-two percent of Canadian ED directors surveyed reported having implemented some form of a fast track system
- **Triaging patients is of unproven benefit.** While triage is an important process to prioritize ED care, its influence on overcrowding and wait times is inconclusive.
- **Ambulance diversion strategies, short stay units, staffing changes, and system-wide complex interventions should also be explored.** Limited evidence suggests that these efforts to address overcrowding at an institutional level should be encouraged and monitored; they have a high chance of success. Furthermore, the results support current efforts to promote multi-component interventions based on a full understanding of the process of care in the ED.
- **No evidence of effectiveness could be identified for some interventions that have been adopted in Canada.** These include float nurse pools, senior ED physician flow shifts, home or community care workers assigned on-site to the ED, over-census on wards, establishment of orphan clinics, "coloured" codes to decongest ED, and "overload" units for in-patients.
- **The relative effectiveness of the reviewed overcrowding interventions is still unknown.** Most studies showed that for almost all outcomes, the interventions were effective to various degrees. A variety of outcomes were reported, however, and studies did not compare interventions to one another.

This summary is based on a comprehensive health technology assessment available from CADTH's web site (www.cadth.ca): Bond K, Ospina MB, Blitz S, Friesen C, Innes G, Yoon P, Curry G, Holroyd B, Rowe BH. *Interventions to reduce overcrowding in emergency departments.*

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EXECUTIVE SUMMARY

Issue

The problem of overcrowding in emergency departments (EDs) has been recognized in Canada and abroad, with various interventions used to address it. Like the problem itself, the interventions are multi-faceted, and little is known about the effect that they have on reducing or controlling ED overcrowding. No evidence-based systematic approach has been used to identify and compare the effects of such interventions. Systematically identifying interventions and their effects is necessary to understand their value in a variety of settings. This information is essential as policy makers and administrators try to address overcrowding at the ED and hospital levels, in regions and across countries.

This is the last in a series of four CADTH reports, which together provide a comprehensive assessment of ED overcrowding in Canada.

Objectives

The main objective of this report was to systematically review the effects of interventions designed to reduce or control overcrowding in the ED. Secondary objectives were to provide a descriptive overview of all studies assessing such interventions, and to evaluate their effectiveness and efficiency based on reported outcomes.

Methods

A systematic review identified relevant literature after a search of multiple databases using a defined strategy, and by hand-searching relevant journals. To be included, studies were required to report data for interventions used to reduce or control events related to ED overcrowding. Studies were restricted to randomized controlled trials (RCTs), controlled clinical trials (CCTs), and observational studies with a control group. The results were synthesized qualitatively, and a "metaview" provided for each category of intervention.

Results

Of 169 potentially relevant studies, 66 reported interventions to reduce or control ED overcrowding. The number of interventions used per study varied from one to 51. The studies were published between 1990 and 2004, with most being conducted in the US, Canada, and the UK.

Interventions that targeted throughput processes were the most commonly studied (51 studies), followed by input (four studies), and output (three studies). The interventions were grouped into fast track (23 studies), multi-faceted interventions (12 studies), staffing changes (eight studies), triage (six studies), diversion strategies (four studies), physician order entry (three studies), and short stay units (two studies). Studies of unique single interventions that could not be placed in any of these categories were considered to be specific processes (eight studies). Most of these have had a positive effect on the overcrowding outcome measured.

Conclusions

Many interventions of varying complexity, intensity, and duration have been applied in an attempt to alleviate or control ED overcrowding. While most seemed to reduce overcrowding, it is difficult to determine the relative value of these interventions, and the lack of comparison studies makes it impossible to say which ones work best. These results suggest that efforts to address overcrowding at an institutional level should be encouraged and monitored, because they have a high chance of success. There is a need for more studies on the specific effects of interventions, and how they might affect the quality of care and patient outcomes. Better reporting is needed on setting characteristics, study design, treatment description, and outcome measures to improve the process of synthesizing evidence on interventions to reduce overcrowding.

ABBREVIATIONS

BAQA	before-and-after quality assessment
CAEP	Canadian Association of Emergency Physicians
CCT	controlled clinical trial
CI	confidence interval
CTAS	Canadian Triage and Acuity Scale
ED	emergency department
EIP	emergency in-patient
EMS	Emergency Medical Services
IQR	interquartile range
LAMA	left against medical advice
LOS	length of stay
LWBS	left without being seen
NENA	National Emergency Nurses Affiliation
NOS	Newcastle-Ottawa Scale
POE	physician order entry
RCT	randomized controlled trial
SAEM	Society of Academic Emergency Medicine
TEP	technical expert panel

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APPENDICES - available from CADTH's web site www.cadth.ca

1 INTRODUCTION

Overcrowding in the emergency department (ED) is a growing problem in many health care systems. Overcrowding is a situation where the demand for ED services exceeds the ability to provide care in a reasonable length of time.[1] The consequences of overcrowding include patients leaving without being seen (LWBS), ambulances being diverted, staff and patients becoming frustrated, patients experiencing long waits and the risk of poor outcomes, and staff being at an increased risk of violence.[2,3]

Despite concerns about how overcrowding hinders the delivery of timely and quality emergency care, it has been poorly measured and studied. Though overcrowding in EDs in some metropolitan academic centres in the US was described over eight years ago,[4] there is a paucity of published studies on the problem in Canada.[5]

The cause of ED overcrowding is multi-faceted,[3,6,7] and the problem is system-wide, with no simple or immediate solutions.[3,8] The fact that hospitals have different characteristics, depending on whom they serve and the communities that they are in, and the fact that there is a variety of demands on emergency services, mean that overcrowding is, by its nature, a complex problem. To address the problem, there is a need to accurately assess the flow of patients through the ED, and to thoroughly understand the many possible interventions.[9] Even when the evidence is clear, instituting reforms will be difficult. Resources may need to be re-allocated, funds will need to be devoted to instituting the intervention(s), and job responsibilities may need to be shifted.

Initiatives to address overcrowding have been undertaken. In 2005, the US Joint Commission on the Accreditation of Healthcare Organizations instituted a new standard that requires hospital leaders to identify and mitigate obstacles to the efficient flow of patients throughout the hospital. The standard identifies overcrowding as a system problem, but recognizes the ED as being particularly susceptible to the poor management of patient flow.[9]

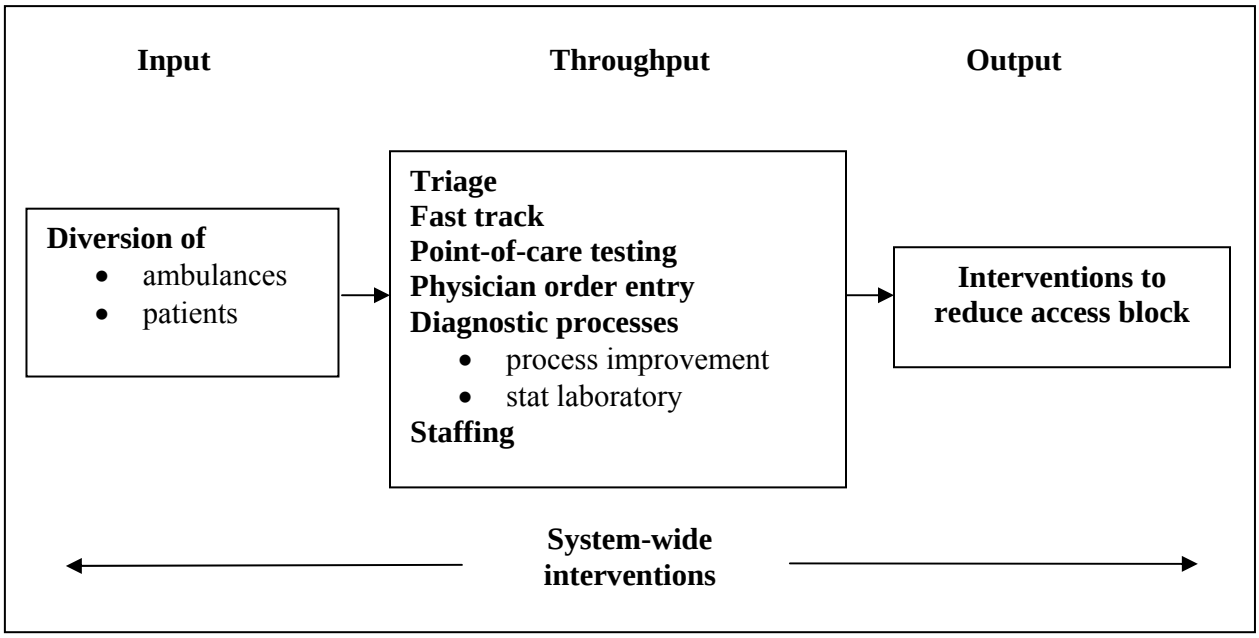
In the UK, the Department of Health has given priority to reducing waiting times in accident and emergency departments in all National Health Service trusts. In 2000, it set as a national target a maximum waiting time of four hours by 2005 for any patient who presents to the ED. This target becomes part of the framework of health and social standards, and a component of the performance standards assessed by the Healthcare Commission.[10] In Canada, the Canadian Association of Emergency Physicians (CAEP), in collaboration with the National Emergency Nurses Affiliation (NENA), has initiated the "Stop the Waiting" campaign,[11] to educate the public and health care workers about the dangers of excessively long waiting times and overcrowding in the ED, and to help push for change. In 2003, NENA and CAEP issued a joint position statement outlining management strategies that might be implemented to reduce ED overcrowding.[12]

Standards, guidelines, and strategies do not carry much value without high-quality evidence regarding the effectiveness of interventions to control or reduce ED overcrowding. The most recent and extensive reports on interventions have been collections of case reports,[9,10,13,14] or reviews addressing specific interventions (e.g., fast track systems).[15] Cooke *et al.*[6] have produced a systematic review of innovations designed to reduce waiting times. The review was restricted to studies published between January 1985 and July 2003, and overcrowding was not the focus.

Interventions to alleviate overcrowding, like the problem they try to address, are multi-faceted and difficult to compartmentalize; what seem to be simple interventions often have multiple effects. Effective interventions are based on the identification of ED processes that create bottlenecks. An input-throughput-output model (Figure 1) has been used to conceptualize ED processes, and to identify strategies for reducing overcrowding.[2,16] This model is based on engineering principles, queuing theory, and compartmental models of patient flow. It allows ED processes to be grouped into three interdependent components: input, throughput, and output. Input interventions target the processes that control the number of patients who present and are admitted to the ED. Throughput interventions target processes related to medical decision making, such as prioritization of care, registration, assessment, diagnostic testing, and treatment. Output interventions aim to improve the flow of patients out of the ED to in-patient beds or to discharge.

The input-throughput-output model was chosen as the conceptual framework for this systematic review, because it focuses on the processes related to overcrowding from the ED's perspective. The model allows a comprehensive view of the multidimensional nature of the problem, and clarifies the ED processes that may alleviate overcrowding if they are changed.

Figure 1: Input-throughput-output conceptual model of interventions to alleviate ED overcrowding



Adapted from Asplin *et al*.,[16] and Fatovich.[17]

2 THE ISSUE

The problem of overcrowding in EDs has been recognized in Canada and abroad, with various interventions used to address it. An earlier report in this series[18] provides a current and Canadian context for this statement. Like the problem itself, the interventions are multi-faceted, and little is known about the effect that they have on reducing or controlling ED overcrowding. No evidence-based systematic approach has been used to identify and compare the effects of such interventions.

Systematically identifying interventions and their effects is necessary in understanding their value in a variety of settings. This information is essential as policy makers and administrators try to address overcrowding at the ED and hospital levels, in regions and across countries.

3 OBJECTIVES

The main objective of this report was to systematically review the effects of interventions designed to reduce or control overcrowding in the ED.

The secondary objectives were to provide a descriptive overview of all studies assessing interventions to reduce or control overcrowding, and to evaluate their relative value (e.g., effectiveness and efficiency, if economic data were provided) based on reported outcomes.

4 METHODS

A protocol for the study was written a priori and followed throughout the review process.

4.1 Literature Search Strategy

4.1.1 Searches of electronic databases

The research librarian did a comprehensive search, and in collaboration with the review team and Technical Expert Panel (TEP), identified relevant electronic databases, and developed search strategies based on the core search terms for overcrowding and emergency departments. Searches were done in 24 electronic databases with the use of appropriate subject headings and the extensive use of keywords, which were crucial for this poorly indexed topic. The search strategies were designed for comprehensiveness, using indexing terms and free-text search terms.

Databases that focus on grey literature, such as SIGLE, GrayLit Network, Dissertation Abstracts, and the NLM Gateway, were included. Google and other Internet search engines (Dogpile, and Copernic Meta) were used to identify web-based information. The original searches were performed in November 2004, with two updates using additional terms conducted in December 2004. The full list of databases searched is provided in Appendix 1, and the detailed search strategies and results are included in Appendix 2. Searches were not restricted by publication status, language, or year of publication.

4.1.2 Manual and grey literature searches

Review team members supplemented the electronic database searches with manual searches and other searches for grey literature. Abstracts presented to the scientific meetings of the CAEP from 2000 to 2004, and to the Society of Academic Emergency Medicine (SAEM) annual scientific meeting from 1999 to 2004 were screened for relevance.

Reference lists and bibliographies of relevant papers and books were also hand-searched for additional citations. Efforts were made to obtain information about unpublished studies by consulting with the TEP.

To further limit publication bias, dissertations (beyond those retrieved from the electronic database searches) were identified through grey literature searches and used to identify relevant literature.

4.2 Selection Criteria and Method

4.2.1 Selection criteria

a) Topic

Studies were required to refer to ED overcrowding as the main objective, or at least as a prominent feature of the overall purpose of the study. A formal statement that included the terms "crowding," "overcrowding," or other synonyms (e.g., increased or increasing patient volumes, increasing number of visits, increasing ED census, ED congestion, or high demand of ED services) was required to be present in the title, introduction, or methods sections.

b) Study design

Randomized controlled trials (RCTs), quasi-randomized trials, before-and-after studies, cohort studies, and case-control studies were all considered.

c) Interventions

Relevant studies reported on interventions designed to reduce or control ED overcrowding.

d) Control

Studies provided a comparison or control population.

e) Outcomes

Studies were required to report data for measures or indicators used to document events related to ED overcrowding. Economic outcomes were also considered.

Only original research was eligible. Articles that did not meet all the inclusion criteria were excluded, including cross-sectional studies, qualitative studies, case studies, systematic reviews, health technology assessment reports, review articles, editorials, opinion letters to the editor, and commentaries. If a study resulted in more than one report (e.g., conference abstract and published manuscript), only the main publication was considered for inclusion.

4.2.2 Selection method

Because of the large number of records retrieved from the computerized database searches, the selection of studies involved a three-stage process:

- Two reviewers (HL, KB) independently pre-screened study titles to exclude irrelevant citations.
- Four reviewers (CS, HL, KB, and MO) independently inspected the titles, subtitles, abstracts, and keywords to select potentially relevant references from those included after pre-screening. At least two people reviewed each citation.
- The full text of the provisionally included articles from the second stage were retrieved, and six reviewers (CF, CS, HL, KB, MBO, and NH) independently decided whether to include or

exclude them using a standard form based on the selection criteria (Appendix 3). At least two people reviewed each citation.

The level of agreement among reviewers at each stage of the selection process was evaluated using kappa (κ) statistics.[19] A κ score in the range of 0.0 to 0.40 was considered to be poor agreement, 0.41 to 0.60 was moderate agreement, and 0.61 to 0.80 was substantial agreement.[20] Disagreements about including or excluding studies were resolved by consensus; when this was impossible, a third reviewer (BR) arbitrated.

4.3 Data Extraction Strategy

Two reviewers (KB, CS) extracted data using a structured electronic form, and developed a profile of each study from the following information: first author, year of publication, country, study design and number of study centres, description of the intervention studied, the ED operation that the intervention modified or affected, and the outcome measures that were used. A third reviewer (SB) verified the accuracy of the abstracted information for all studies. Disagreements were resolved by consensus.

4.4 Strategy for Quality Assessment

Two reviewers (KB, CS) assessed the methodological quality of the studies using various methods depending on the study design, with the final score reached by consensus. The quality of clinical trials was assessed using the Jadad criteria[21] (Appendix 4). The maximum score is five, and studies scoring <3 are usually considered to be of low methodological quality.[21] This scale was selected to assess the quality of CCTs and RCTs, because its measurement properties have been tested, providing rigorous evidence to support its use.[21,22]

The methodological quality of cohort studies was evaluated using the Newcastle-Ottawa Scale (NOS)[23] (Appendices 5 and 6). This is an eight-item tool that uses a star system to assess methodological quality across three perspectives: the methods for selecting the study groups; their comparability at baseline; and the ascertainment of the outcome of interest. Scores range from zero to nine stars. The NOS has been used by review groups at the Cochrane Collaboration to evaluate the quality of observational analytical studies. The measurement properties of the NOS are being examined. The face-content validity and inter-rater reliability have been established; studies on criterion and construct validity are in progress.

Because of the lack of commonly accepted scales for assessing the methodological quality of before-and-after studies, the research group developed a 10-item before-and-after quality assessment (BAQA) checklist (Appendix 7), which is based on the NOS for pre- and post-studies. A star system is used to rate the selection of pre- and post-intervention groups, the comparability of groups, the assessment of outcome, and the comparability of time frames of the pre- and post-intervention periods. Scores range from zero to 14 stars. The reliability and validity of the BAQA checklist have not yet been evaluated, and an assessment plan is being formulated for evaluating the instrument's measurement properties.

4.5 Data Analysis Methods

All data summaries were produced using SAS® (version 8.2, Cary, US). Graphics were produced using S-Plus® (version 6.0, Seattle, US).

Two reviewers individually categorized studies by intervention. The final decision was made by consensus (KB, MO), and when there was disagreement, a third reviewer (BR) arbitrated.

The first step in synthesizing data was to evaluate the quality of studies. Qualitative analysis provided a detailed description of the critical issues and characteristics of the studies. Evidence-based tables were developed based on recommendations from the TEP regarding content and format. The tables included information on the source of the article, study design, setting, intervention, study periods, and outcomes reported. The evidence tables included the main conclusions from individual studies, and the methodological quality of the studies as assessed by the reviewers.

Because of the heterogeneity of the reporting of outcomes, meta-analytic techniques were not used in the statistical analysis. Outcomes from before and after periods, or intervention and control groups were extracted, and the percent change from the before period or control group was calculated. Outcomes of particular interest were length of stay (LOS), waiting time (to be seen by an MD or a medical practitioner), number of patients who LWBS, waiting time for admission, and number of ambulances diverted.

For interventions that were examined in >5 studies, a graphic summary or "metaview" of the percent change was produced to present the effectiveness of the intervention. If multiple values were reported for a period or group, the mean value was calculated by adding the values reported, and dividing by the number of values. The "metaviews" included RCTs, controlled trials, retrospective cohort studies, and before-and-after studies. The study design was coded in the graphics to incorporate the quality of the evidence for the effectiveness analysis.

Descriptive summaries were provided for those interventions that were reported in <5 studies.

5 RESULTS

5.1 Quantity of Research Available

The computerized search identified a total of 15,357 citations. After removing duplicates and irrelevant references, 1,259 potentially relevant studies remained. A second screening of titles and abstracts yielded 632 studies to be retrieved for further review (487 and 145 references from electronic searches and grey literature respectively). The inclusion criteria were applied in two rounds. In the first round, studies were selected for a review of measures of overcrowding: 452 studies were excluded, and 169 were included (Figure 2). There was 78% agreement on included studies (κ: 0.63; 95% CI: 0.58; 0.68; n=619 studies). Eleven studies are still awaiting assessment (Appendix 9). Because of delays in the translation of articles published in languages other than English, a decision about their relevance could not be made in this review. The CADTH report on measures of overcrowding[24] lists the studies that were excluded at this stage of the review.

In the second round, 103 studies were excluded, and 66 were included (Figure 2). The weighted kappa for agreement between reviewers was 0.69 (95% CI: 0.51; 0.87), indicating good agreement. Appendix 8 shows the complete list of excluded studies.

5.2 Study Characteristics

Among the eligible studies, 66 reported interventions to reduce or control ED overcrowding. The number of interventions per study ranged from one to 51. The studies were published between 1990 and 2004.

Most of the studies were conducted in the US (29), Canada (13), the UK (nine), Australia (five), and Spain (three). The remaining studies were done in Hong Kong, Israel, New Zealand, Singapore, Sweden, Switzerland, and Turkey (one study each). Among the studies, 57 were single-centre, and nine were multi-centre. The studies used a variety of methodological approaches to address their research questions: 50 used a before-and-after design, seven used a controlled trial design, seven used a cohort study design, and two used an RCT design (Appendices 10 and 11).

The lack of reporting of economic outcomes in the studies included in this review precluded the analysis of the efficiency of interventions that were implemented to reduce ED overcrowding.

5.3 Methodological Quality

The BAQA median score of methodological quality for before-and-after studies was 7 (IQR 6, 8). Methodological weaknesses include a lack of comparability of the pre- and post-intervention groups, low reliability or accuracy of outcome assessment, a lack of a description of how outcome assessment was conducted, and a lack of representativeness of the pre- and post-intervention samples.

For RCTs and CCTs, the median Jadad score was 1 (IQR 1, 2). The methodological weaknesses most often displayed were a lack of appropriate methods of randomization, and a lack of double-blinding.

In the case of cohort studies, the median score on the NOS was 6 (IQR 5, 6). Methodological weaknesses were found in outcomes assessment, and the adequacy of follow-up of cohorts.

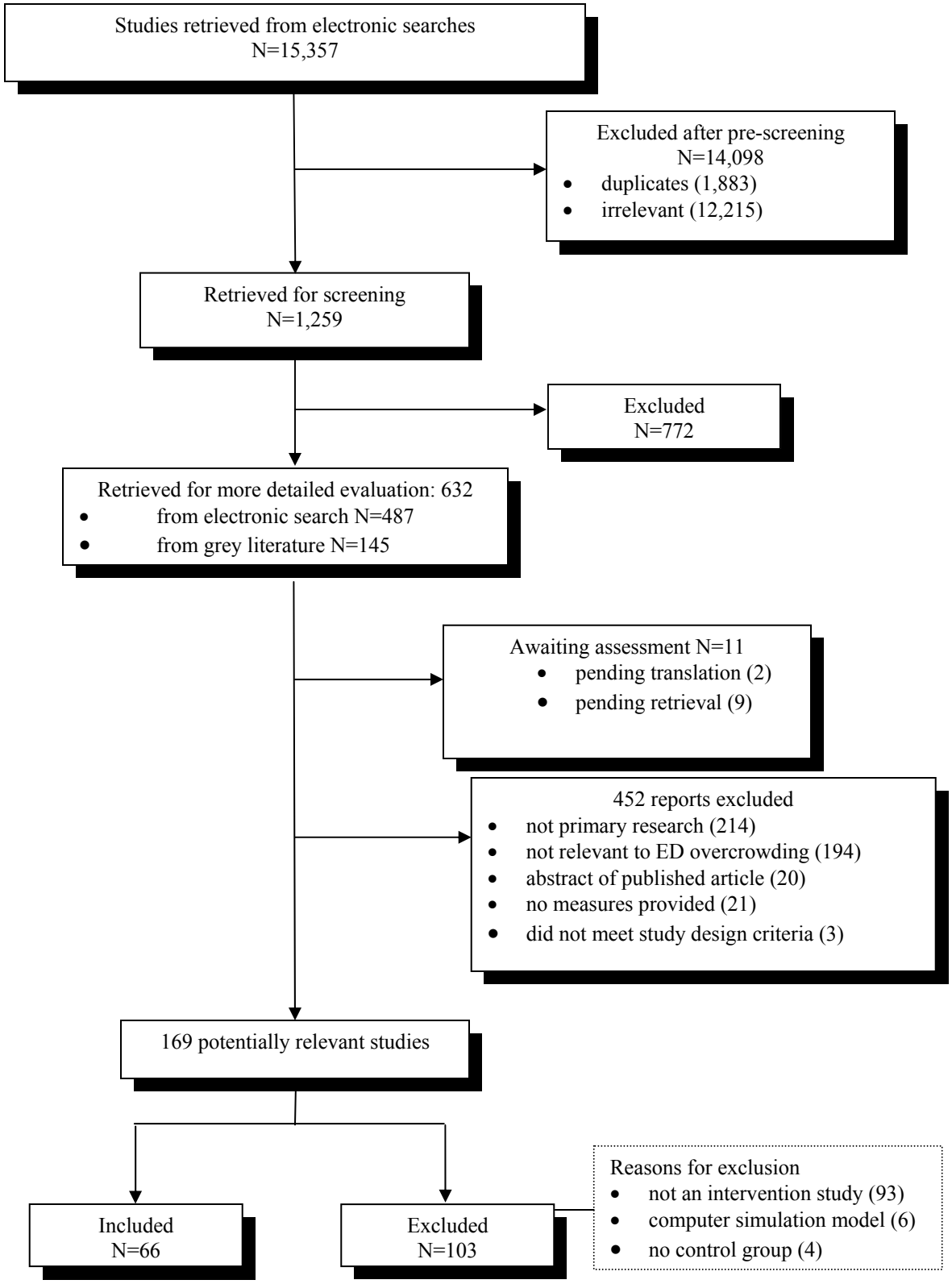
5.4 Data Analysis and Synthesis

The diversity of outcomes and the lack of data on measures of dispersion as they relate to estimates of effects precluded pooling the data for the quantitative analysis. Results are presented qualitatively, and a description of the "metaviews" of individual studies, grouped by type of intervention, is provided.

5.4.1 Category of intervention

The studies were grouped according to their particular intervention: fast track (23 studies), multi-faceted interventions (12 studies), staffing changes (eight studies), triage (six studies), diversion strategies (four studies), physician order entry (three studies), and short stay units (two studies). Studies of unique single interventions that could not be placed in any of these categories were considered specific processes (eight studies). The interventions were grouped according to the three

Figure 2: Study selection process



interdependent components of the input-throughput-output model. Interventions that targeted throughput processes were the most commonly studied (51 studies), followed by input (four studies), and output (three studies). Three classes of interventions targeted >1 process interventions that cut across input-throughput-output, and were classified as system-wide interventions (four studies), throughput-output interventions (three studies), and input-throughput interventions (one study). The studies were also grouped according to those that used one intervention (50 studies), and those that used composite interventions (16 studies) (Appendix 11).

The single-intervention groups were ambulance diversion protocols, fast track systems, short stay units, physician order entry, triage, point-of-care testing, staffing, and miscellaneous single-process interventions that included a dedicated stat laboratory and the use of an electronic patient tracking board.

a) Fast track

Twenty-three studies reported on the use of a fast track system to reduce overcrowding (Figure 3). The 23 studies comprise 12 before-and-after studies,[25-36] five controlled trials,[37,39,40,42,43] five cohort studies,[38,41,44-46] and one RCT.[47] All studies targeted throughput processes.

Overall, 16 studies reported outcome data on total LOS. In 15 studies, the intervention group showed an improvement in LOS when compared with the control group.[26,30,32-34,37-42,44-47] Two studies showed no improvement.[31,37] One study[37] was counted twice for the waiting times outcome, because it reported positive results and negative results for LOS for patients.

Ten studies reported outcome data on waiting time. In eight studies, waiting time improved from that of the control group.[25-27,31,33,36,37,42,43] One study reported that a fast track system had a negative effect on waiting time,[45] and one study reported a positive and a negative impact on waiting time.[37]

Outcome data for patients who LWBS were reported for six studies. All reported improvements in the intervention groups.[28,30-32,34,40] The change in waiting time for admission was reported in one study, which saw an improvement over that of the control group.[29]

b) Multi-faceted interventions

Multi-faceted interventions were reported in 12 studies (Figure 4). All 12 used a before-and-after design.[48-59] Five studies reported on interventions that targeted throughput processes,[51,52,54,55,57] three targeted system-wide processes,[49,53,59] three targeted throughput and output processes,[48,56,58] and one targeted output processes.[50]

Outcome data for overall LOS were reported in seven studies, and all reported improvement.[49,51,54-58] One study[58] reported a negative change in overall LOS for admitted patients.

Outcome data for waiting time were reported in three studies. In all three, the waiting times improved compared to the control group.[51,52,56] Five studies reported outcome data on patients who LWBS, with improvements reported in four of the five.[51,55-57]

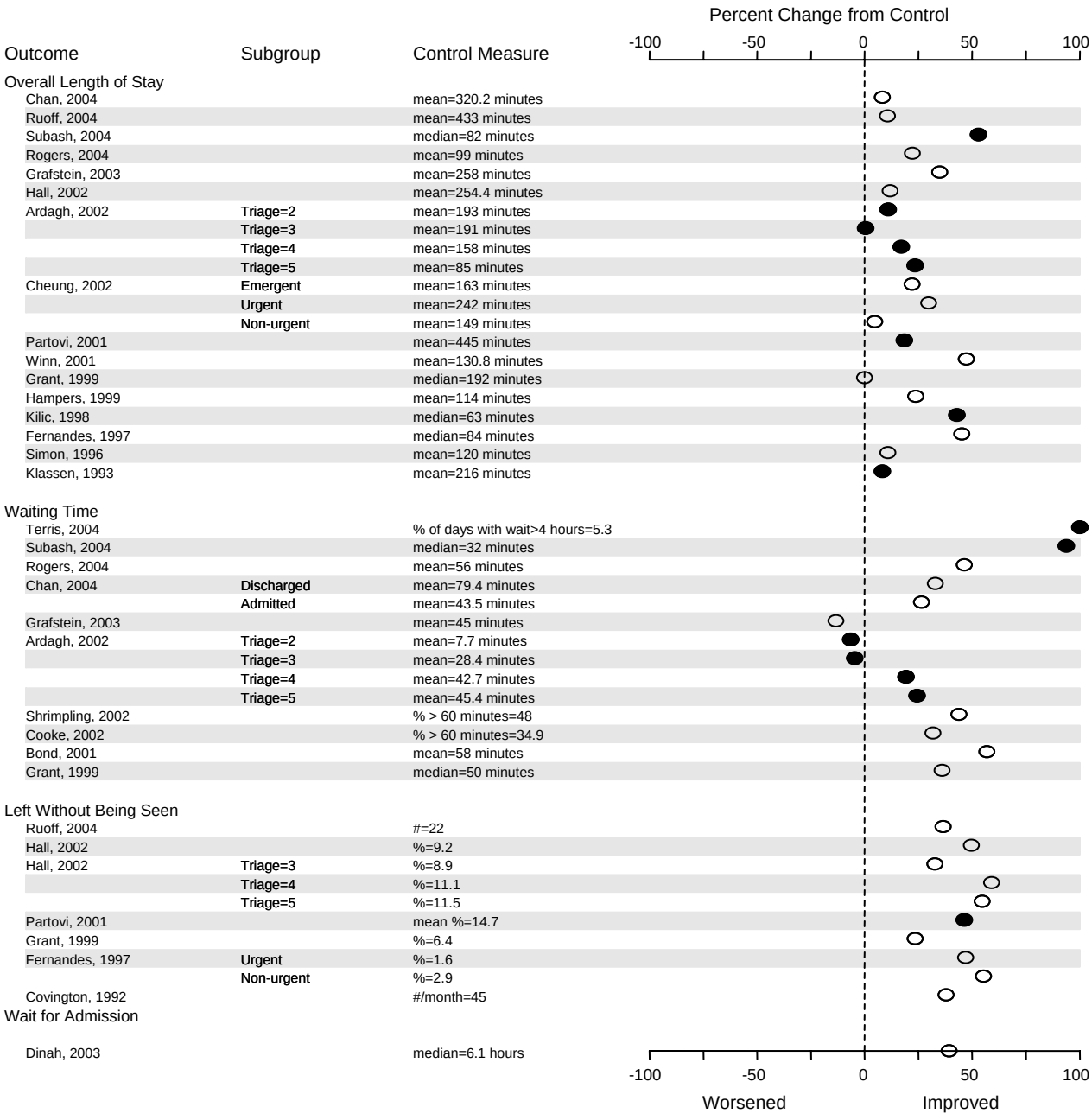
c) Staffing changes

Eight studies introduced staffing changes to address ED overcrowding (Figure 5). These studies were before-and-after designs, with seven targeting throughput processes,[60-66] and one targeting input-throughput processes.[67]

Four studies reported outcome data on the overall LOS; three studies reported improvements;[61-63] and one reported no improvement.[66]

Outcome data for waiting time were reported in five studies, with all five reporting reduced waiting times.[60,61,63-65] One study[64] reported an increase in waiting time for urgent cases.

Figure 3: Fast track



Black dots represent highest quality designs (i.e., RCTs), while open circles represent all other designs. Circle size is similar irrespective of sample size.

Figure 4: Multi-faceted Interventions

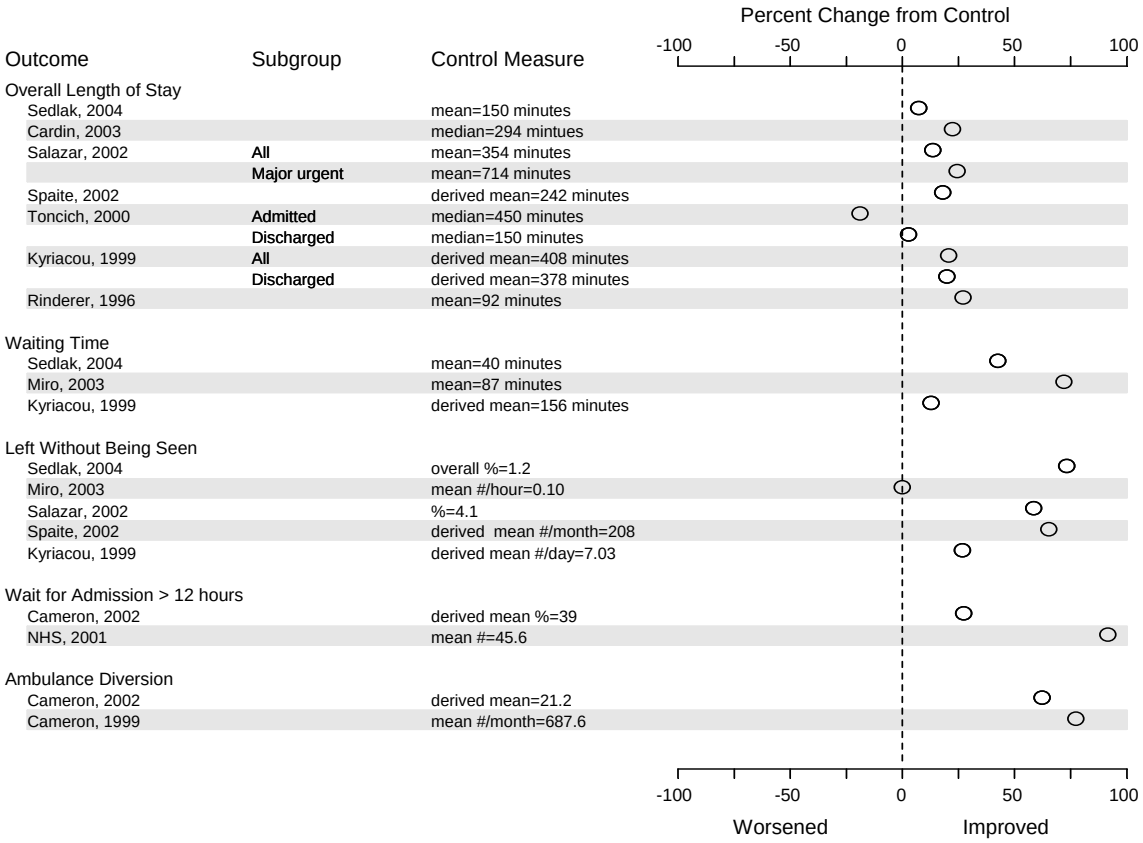
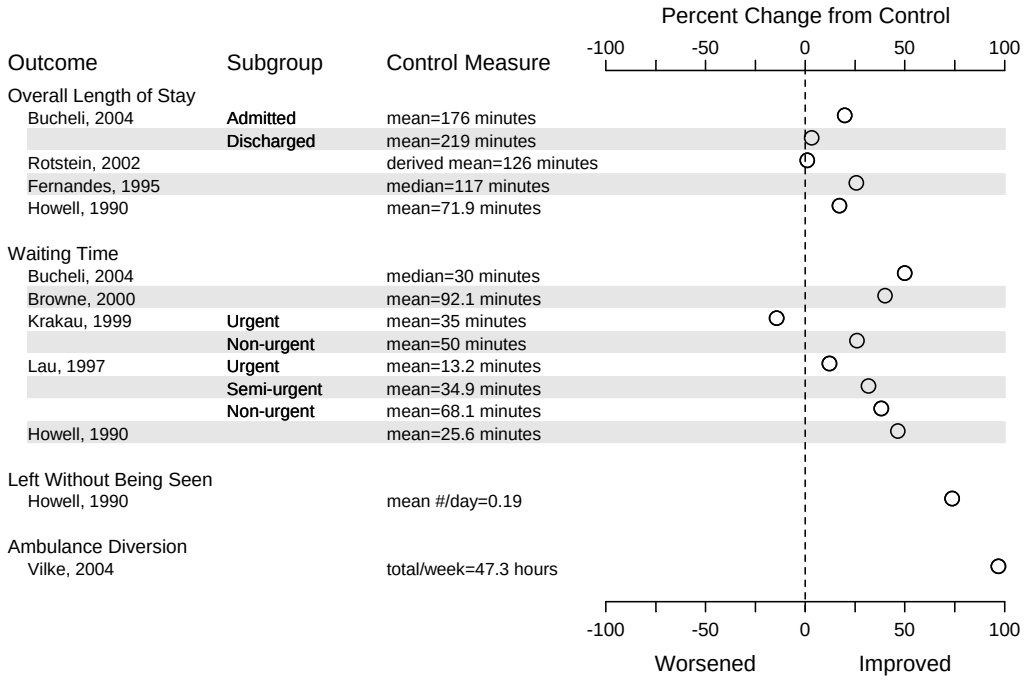


Figure 5: Staffing Changes

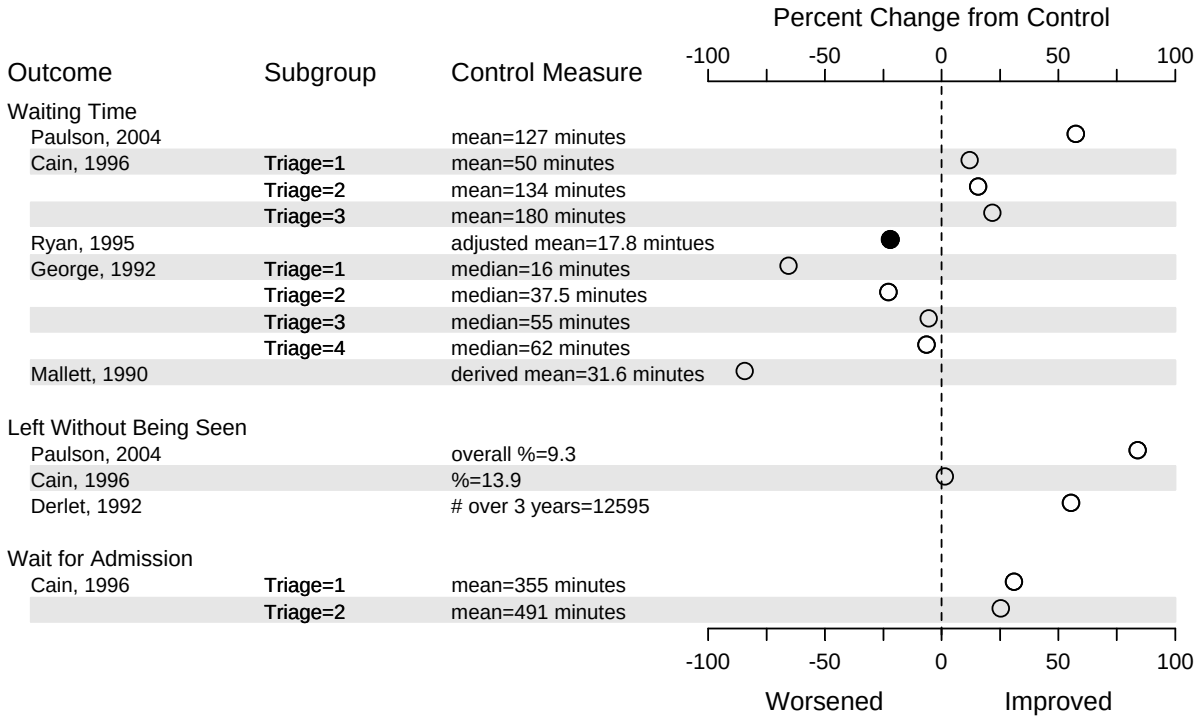


One study reported outcome data for patients who LWBS,[63] and showed a reduction in the intervention group. Another study reported a reduction in the hours of ambulance diversion for the intervention group.[67]

d) Triage

Six studies examined the use of triage to reduce overcrowding (Figure 6): four were before-and-after studies,[68-71] and two were controlled trials.[72,73] Five of the interventions targeted throughput processes,[68,70-73] and one targeted input processes.[69]

Figure 6: Triage



Five studies reported outcome data for waiting time. Two reported reduced waiting times,[68,71] and three reported increased waiting times.[70,72,73]

Outcome data for patients who LWBS were reported in three studies. Two reported a reduction in the number of patients who LWBS,[69,71] and one reported no change between the intervention and control.[68]

One study reported on admission delays. There was a reduction in waiting time for patients at triage levels 1 and 2.[68]

e) Diversion Strategies

Interventions that altered patients' access to the ED through the use of ambulance diversion protocols were reported in four studies, all of which used a before-and-after design.[74-77] Two studies reported on interventions that targeted input processes,[75,77] one targeted throughput processes,[74] and one targeted system-wide processes.[76]

Three studies reported reductions in the number of hours on ambulance diversion in the intervention groups compared with the control groups.[75-77] One study[74] reported reduced waiting times for critical care patients in the ED.

f) Physician order entry

Three studies examined the effect of physician order entry.[78-80] Two used a before-and-after design,[79,80] and one used a retrospective cohort design.[78] All three studies targeted throughput, and all provided outcome data for ED LOS. A decrease in LOS was reported in two studies after the introduction of the intervention,[78,79] while one study reported a subsequent increase.[80]

g) Short stay units

The effect of short stay units on reducing ED overcrowding was reported in two studies.[81,82] Both used a before-and-after design. One reported on an intervention that targeted throughput processes,[82] and the other reported on an intervention targeting output.[81]

The first study reported a decrease in ED LOS for treat-and-release patients for the intervention group compared with the control group.[81] The second study reported a reduction in the number of patients who LWBS, and the occurrence of ED diversion.[82]

h) Specific processes

Eight studies reported on interventions that targeted specific processes.[83-90] A before-and-after design was used in seven studies,[83-86,88-90] and one study used an RCT design.[87] One study reported on interventions that targeted input processes,[89] six reported on throughput interventions,[83,84,86-88,90] and one reported on an output intervention.[85]

The following eight interventions and their associated outcomes were reported in the studies, with improvements being reported for almost all outcomes of interest.

- The use of an electronic tracking board decreased LOS, and the number of patients who LWBS.[85]
- Dedicating radiology staff to the ED, and re-engineering the X-ray service reduced X-ray turnaround time, fast-track cycle time, and time from arrival to treatment by the emergency physician; and improved overall ED LOS.[84]
- Instituting an admission system based on telephone consultation between ED physicians and in-house hospital staff reduced admission times.[85]
- The use of point-of-care testing for selected laboratory tests reduced the median LOS.[87]
- A dedicated stat laboratory reduced median within-laboratory turnaround times (e.g., specimen collection, arrival in laboratory, accessioning complete blood count, and transportation). The authors concluded the study failed to show that a dedicated stat laboratory in the ED could improve turnaround and expedite the disposition of patients.[88]
- Implementing a satellite laboratory and research nurse in the ED for point-of-care testing significantly reduced ED LOS and laboratory turnaround times.[86]
- An alternative care destination program for patients identified by emergency medical services (EMS) personnel as low acuity decreased the proportion of patients who received care in the ED.[89]
- The institution of bedside registration improved the time from triage to room across all triage classifications. There was no effect on the mean time from room to disposition.[90]

5.4.2 Interventions implemented in EDs across Canada

A survey of ED directors across Canada (see the CADTH report[18] for a description of the methods) showed that 98 out of 158 (68%) tried at least one intervention to address ED overcrowding. Overall, 204 interventions were reported by the ED directors. Most interventions were set in EDs in Ontario (72), Québec (61), and British Columbia (30). Interventions were implemented less often in EDs in other provinces: 13 interventions were tried in Nova Scotia, 13 in Alberta, five in New Brunswick, five in Saskatchewan, four in Manitoba, and one in Newfoundland and Labrador. Of the 144 interventions that were reported as initially successful, 81% (n=117) were described as still effective when the survey was completed.

The interventions were largely heterogeneous in their characteristics, but had some commonalities.

Eleven interventions were designed to influence input processes. Some were minor modifications to the ambulance operating system (e.g., managing ambulance transfers through dispatch, or using ambulances as point of care), whereas others aimed at strengthening the collaboration with other primary care and outpatient services (e.g., empowering family doctors to consult specialists directly rather than referring patients to ED for revisits, establishing clinics with several services to reduce admissions and return visits, opening a medical day clinic for Canadian Triage and Acuity Scale (CTAS) 4 and 5 patients, and reforming the psychiatric outpatient clinic). Other input interventions implied a wider participation of the community (e.g., education through the media). Others were implemented in the ED to restrict the flow of arriving patients (e.g., restricting the ability of non-emergency physicians to book patients into the ED, and telling patients sitting in the waiting room that they would not be seen for >3 hours because they were CTAS 4 and 5).

Sixty-one interventions were designed to influence throughput in the ED. Most aimed to increase or improve the workforce in the ED (e.g., additional clerking, nursing, or medical staff; patient flow specialists; addition of extra hours for MD coverage; and backup practitioners), whereas others addressed specific components of the process of care (e.g., triage and fast track). Using guidelines, making administrative changes such as increasing the number of stretchers for EMS personnel to offload patients, and using colour codes to identify patient acuity were also reported. Another group of interventions involved changes in communication with specialty groups (e.g., radiology, laboratory) to speed up investigation in the ED.

Forty-seven interventions were designed to influence output. Some involved changes in the practices of care in the hospital (e.g., cancelling elective surgeries, cancelling next-day admissions, closing the intensive care unit, preventing surgical services from admitting cases via the ED). Other interventions were designed to create and staff "overload" units for in-patients waiting for admission to the hospital. In some cases, with the implementation of informal or "virtual" units, patients were sent to the hallway on the floor of the admitting unit. In others, overcrowding in wards was allowed to reduce congestion in the ED, and committees were created for discharge planning and bed management in the hospital. In other instances, codes of action were implemented (e.g., "code orange internal," where inpatients go to ward hallways when a certain level of crowding occurs, "code burgundy" frees in-patient beds, and "code ER" expedites possible discharges).

Six interventions combined approaches to target throughput-output processes (e.g., having a MD coordinator in the ED and admissions, implementing plans for admission, and aiming for a specialist consultation or discharge in <8 hours).

Seventeen interventions were implemented at a system-wide level. Some used formal decongestion plans and administrative actions at the hospital level (e.g., policies on bed use and bed spacing, creation of an integrative committee to review the sequence of care and bed management), whereas others used educational activities to sensitize hospital administrators and health care staff regarding the effects of ED overcrowding. In some cases, interventions involved the participation of health ministries and other provincial authorities.

Appendix 13 provides examples of interventions implemented in EDs across Canada (not all of which have been evaluated in the scientific literature), and collected in the survey on ED overcrowding.

6 DISCUSSION

This systematic review examined the effectiveness of interventions designed to reduce or control overcrowding in the ED. The analysis is based on 66 studies that used control groups. This review identified eight classes of interventions targeting at least one stage of patient flow (input, throughput, or output) in the ED, with some interventions targeting >1 stage. The results show that in most studies, and for almost all outcomes, the interventions were effective. Nine (14%) of the 66 studies reported a worsening of an outcome of interest in the intervention group compared to the control group (Appendix 11), and six studies reported no effect.

Most studies (58) were performed primarily in countries that practise emergency medicine with specially trained, hospital-based doctors providing care to all patients presenting to a separate ED. Emergency medicine in these countries is a recognized, independent specialty with professional associations, and a structured training program with recognized qualifications.[91] The remaining studies were conducted in countries that do not conform to the emergency medicine specialty model. Because of these differences, not all interventions may be equally effective in all countries.

6.1 Methodological Quality

The methodological quality of studies that used a controlled trial or cohort design was low. The main weaknesses were inappropriate randomization (when performed), a lack of random allocation, and a lack of double blinding. The ethical and methodological difficulties of structuring a randomized, double-blinded trial in emergency care may prevent researchers from using this study design in single-centre trials; cluster randomization, however, should be possible. Furthermore, the double-blinding of interventions may be difficult to implement in the ED, so few RCTs were found and the controlled trials scored poorly on quality scales. The use of this quality tool may result in studies scoring lower in methodological quality. Other quality components, such as the description of withdrawals and dropouts, were also reported poorly.

The quality of cohort studies on the NOS was moderate; the deficiencies were in the areas of outcomes assessment and the adequacy of follow-up of cohorts. Results obtained using the NOS should be interpreted with caution until data regarding its validity and reliability are published.

The before-and-after studies were of moderate quality, according to the scores obtained with the BAQA checklist. The face validity of this tool suggests that these scores are a valid reflection of the quality of the before-and-after studies. The main weaknesses were comparability of the pre- and post-

intervention groups, reliability and accuracy of outcome assessment, description of procedures for outcome assessment, and the representativeness of the pre- and post-intervention samples. This tool is in the early stages of development, and is yet to be assessed in terms of validity and reliability. As a result, caution is advised when interpreting these results.

6.2 Effectiveness of Interventions

The implementation of effective interventions is based on the identification of ED processes that create bottlenecks. The input-throughput-output model has been used to conceptualize ED processes, and to identify strategies for reducing overcrowding;[9] this is not, however, a universally accepted classification scheme. Cooke *et al*. reviewed 109 studies in their systematic review on innovations to reduce ED waiting times.[6] Cooke *et al.* included studies without controls (cross-sectional and descriptive studies), whereas this review restricted the level of evidence to studies with controls. Cooke *et al.* included any study reporting an outcome measure that influenced waits or attendance at the ED. This review examined only those studies that were explicitly about alleviating or controlling ED overcrowding. Cooke *et al.*'s interventions were grouped into out-of-hospital care, primary care, ED, patient education, diagnostics, admission avoidance, bed management, delayed discharge, and staffing; this review did not examine primary care or patient education.[6]

A collection of case studies published by the NHS Modernisation agency organized interventions in a matrix that combined four levels of urgency (immediate admission, admission with significant LOS, longer assessment and observation including diagnosis and treatment, and treated and discharged quickly) with seven "themes" (bed management, access to senior or specialist opinion, scheduling emergency care, discharge, dedicated assessment service, access to diagnostics, and "see and treat" models).[13]

Finally, in another study, interventions were grouped according to the operational issues contributing to ambulance diversion: problems external to the ED and hospital, internal ED operational issues, and other hospital problems affecting ED function.[92]

Despite the other methods of categorization and the difficulty assigning some interventions to a single-process category, grouping interventions according to the input-throughput-output model is easily understood. This is consistent with a well known model for categorizing ED processes and measures of overcrowding,[16,17,93] thus providing a unified conceptual scheme for analyzing all aspects of ED overcrowding.

6.2.1 Fast track systems

Fast track systems operate on the theory that by first serving those patients who can be taken care of most quickly, waiting times are minimized for everyone.[6,15] Fast track systems and minor injuries units have been introduced in an attempt to eliminate excessively long waits for non-urgent patients who are often assessed and treated quickly. The results of this review support the conclusion that fast track systems can reduce overcrowding by reducing ED LOS and waiting time, and by reducing the number of patients who LWBS. Yoon conducted a review of the available literature that compared fast track systems to regular ED operations on LOS.[15] He found that low acuity patients seen through a fast track area have a shorter LOS than similar patients seen through regular ED operations, and that fast track operations seem to be less resource-intensive than regular EDs for managing low acuity patients.[15] Yoon's review was based on nine low quality studies, compared to this review of

23 studies. Cooke *et al*. also concluded that fast track systems reduce waiting times for non-urgent patients.[6]

While this seems to be a reasonable alternative for EDs that are considering solutions to their overcrowding problems, there are several concerns with this approach. First, size and physical limitations can prevent the establishment of a fast track system in an ED.[15] Second, physician, nursing, and other resources are still required, and the financial implications of this approach are unclear. Finally, such a system rewards the minor injuries and medical problems, and diverts resources from the most serious patients.

6.2.2 Multi-faceted interventions

This review identified 12 multi-faceted interventions that demonstrated consistent findings; all but two reported improvements in the outcomes of interest. Cooke *et al*. note that these studies show the different but commonly used routes that can be taken to reduce overcrowding.[6] Though difficult to implement, multi-faceted interventions can reduce overcrowding by addressing service pressures across the ED or hospital, thereby reducing ED LOS, waiting time, ambulance diversion, and numbers of patients who LWBS.

Multi-faceted interventions seem to offer reasonable solutions to ED overcrowding, yet concerns also exist with this approach. First, the complex nature of these interventions precludes drawing any conclusions regarding the specific contribution of one component. Second, impressive physician, nursing, and other resources are required for development, training, implementation, and evaluation of these often system-wide interventions. It is unclear whether the costs of such interventions justify the outcomes, or whether such resources could be more efficiently applied elsewhere.

6.2.3 Staffing

In a survey on overcrowding by the American College of Emergency Physicians, respondents reported that one of the biggest obstacles to solving the problem was lack of ED staff (43%).[94] This review found that six out of nine studies reported improvements in ED LOS, waiting times, patients who LWBS, and ambulance diversion rates when staffing changes were implemented. Cooke *et al*. reported that the use of senior medical staff may reduce admissions and decrease delays; they recommended more research to better assess the impact of adding nurse practitioners and other staff.[6] It appears that increased staffing can have a positive effect on ED LOS, waiting time, number of patients who LWBS, and the amount of time spent on ambulance diversion.

There are concerns about this approach. First, the availability of well trained and experienced staff in emergency medicine, at least in North America, is limited.[12] Just adding staff (i.e., not emergency trained or experienced) may negate the potential positive effects of staffing changes. Some have argued that additional staff will have no effect if the space to assess patients is unavailable (except perhaps in the waiting room). Finally, it is unclear what role additional staff should have to maximize the efficiency of the ED. For example, a physician liaison position to accept transfers, expedite patient care, and deal with administrative duties may be better than adding another physician to see patients.

6.2.4 Triage

Triage is the process of prioritizing patients who present to the ED. There have been controversies about whether high volumes of low acuity patients contribute to overcrowding in the ED.[73,95] In the absence of a fast-track system and in an attempt to cope with limited resources, some EDs aim to alleviate overcrowding by diverting inappropriate patients away from the ED. This review identified one study that looked at the effectiveness of this intervention.[69] At least two studies excluded here found that referral guidelines could not be consistently applied, staff had limited ability to predict which ED visits were appropriate, and the studies lacked sensitivity.[96,97] Washington *et al*.[98] found that detailed screening criteria could be used to identify ED patients who could be safely referred for next-day care, though the sampling method precluded generalization of their findings. These studies showed that the diverting of patients can be done, but they did not show that doing so had any effect on overcrowding.

The remaining studies of triage assess the effect of prioritizing patients for assessment and treatment without using deferral. George *et al.* concluded that formal triage system is better than no triage system, but the comparative benefits are not always observed.[72] This is the same conclusion reached by Cooke *et al*.,[7] who found that implementing triage with the sole aim of prioritizing patients may delay care, while other systems that combine prioritization, assessment, and treatment are more likely to save time. For this review, the latter forms of triage were grouped with the fast track systems, because it was believed that the attempt to shorten the assessment and treatment time of lower acuity patients, regardless of how it is done, is a fast track system. At least two studies[68,72] included times for triage levels 1 and 2 as outcomes. As these two levels represent the highest acuity patients who ought to be seen as soon as possible (those with severe trauma or who require resuscitation), little if any change in the outcomes at these levels should be expected; high acuity patients do not wait to be seen, do not LWBS, and do not wait as long for admission.

The impact that triage had on patient waiting times has been displayed in terms of percent change, which tends to minimize the size of difference between the baseline measure and the intervention. Using real time changes rather than percent change may lead to a different result. For example, a 20% reduction in time from four hours would look different from a 20% reduction from two hours, yet both appear the same in the display used here.

There are some concerns with this approach to triage. First, triage was intended to prioritize patients in overcrowded EDs. An ED that is not overcrowded does not need a triage process. As a result, the triage process results are inconclusive. There are a variety of triage systems available. Each consumes different resources, and comparisons of triage systems were not undertaken. Finally, researchers in emergency medicine have questioned the reliability of triage, and this may contribute to inconclusive results in these studies.

6.2.5 Diversion

Four studies about ambulance diversion reported improvements in the outcome for the intervention groups. One study reported on the changes in patterns of ambulance diversion after hospital restructuring that involved the closure or merger of nine acute care hospitals in Toronto.[99] The authors concluded that hospital restructuring may worsen ED overcrowding.

Diversion is only possible at selected locations. For example, in a survey of Canadian ED directors,[18] 27% stated that they provided emergency medical services to communities where ambulance

diversion is prevented by provincial policy, or was impossible (only ED in the region). Diversion makes sense in settings where it is possible to coordinate ambulances; the evidence for this is limited.

6.2.6 Other interventions

Finally, results for physician order entry, short stay units, and specific processes were positive, supporting the belief that interventions are effective in improving outcomes associated with input outcomes (e.g., reduction in the occurrence of ED diversion) and throughput outcomes (e.g., ED LOS or number of patients who LWBS).

Because of the limited number of studies identified in this group, it is difficult to conclude that these interventions are effective. Additional research is urgently needed.

6.3 Negative Results

Because most of the studies included in this report identified positive results, we thought it was appropriate to examine the studies that reported negative results in more detail (Appendix 11). The type of intervention cannot be used to explain these results, because studies focused on a variety of interventions: fast track system, staffing, triage, physician order entry, bedside registration, and a multi-faceted intervention. The date of the intervention does not seem to have influenced outcomes, because the year of publication for these studies ranged from 1990 to 2003. Location patterns and common study designs could not be identified for the negative studies.

Total ED volume may partially explain the results, as only three studies occurred in high volume EDs (ED census >50,000), where overcrowding is known to be more problematic. There were also common outcome measures in the studies reporting negative results: six studies reported a negative effect on waiting times, and two of three studies that focused on high acuity patients (triage levels 1 and 2) reported negative results in ED LOS. None of these studies differ in characteristics from those that reported positive results. As a result, the differences might be explained by factors that were not identified in the studies or were not revealed by the authors.

6.4 Limitations

This systematic review was conducted according to a defined protocol and standard guidelines to identify and analyze the scientific literature on interventions for ED overcrowding. The following limitations should be considered when interpreting the results.

The heterogeneity of the literature regarding the settings, the nature of the interventions, and outcome measures precluded the use of common approaches to aggregating data such as meta-analysis or simple comparisons of odds ratios. The research studies were often more complex or multi-faceted than typical RCTs or observational studies in other settings.

There are few comparative studies of ED overcrowding interventions. For example, studies examining two strategies such as fast track versus physician administrative shift were not identified. Consequently, between-study comparisons rather than within-study comparisons were all that were available. As a result, we were unable to use the research to determine the relative benefits of one group of strategies compared to another.

Complex interventions are reported frequently, and while effective in most cases, the contribution of each component of the strategy is impossible to determine. Moreover, the differences among the component interventions preclude any discussion of their relative effectiveness. The lack of an economic evaluation of these and other interventions also precludes a discussion of the efficiency of one method over others.

The methodological quality of the included studies varied. For example, there were few RCTs of policy or management interventions. This may be seen as a weakness, but RCTs of such interventions are difficult, and expecting them may be asking too much of the administrators who are responsible for implementation. If that were the case, one would expect higher quality CCTs in an effort to address the biases associated with non-RCT evidence. For example, comparable and representative comparison groups, blinded or unbiased outcome assessments, concurrent controls, comprehensive outcome assessment, and prospective design are all needed to improve the validity of the results.

Because no single accepted measure of overcrowding exists, outcome reporting was also variable. This presents several problems. First, the collection of multiple outcomes can increase the chance of finding a significant result (i.e., data dredging). Second, most of the outcomes are process markers, rather than clinically relevant outcomes for patients (e.g., death, morbidity, surgical intervention). Because of the infrequent occurrence of these outcomes, studies powered to detect differences would require massive sample sizes. Finally, for studies that provided data for multiple times in outcomes, a decision on the most appropriate value had to be reached. The total ED LOS as an outcome measure was reported to allow comparisons across the studies. Most of the outcomes reported here are surrogates for overcrowding; reducing LOS and waiting times will presumably improve overcrowding—but they are not the same as overcrowding. This is an area of future research in ED overcrowding.

There is a possibility of publication bias in this review, because successful interventions are more likely to be published. Also, it is probable that many hospitals institute policy changes or implement interventions without formally studying the improvement or deterioration that occurs as a result. To address this concern, a comprehensive search was conducted with a systematic search strategy to reduce bias. Attempts were made to identify unpublished studies, and abstracts from recent conference proceedings were also searched. The authors believe that this strategy identified most of the research available regarding interventions to reduce ED overcrowding.

The possibility of selection bias must also be considered. The selection criteria were well defined, multiple independent trained reviewers were involved, agreement was recorded, and disagreements were resolved by third party adjudication. Using these techniques, it is unlikely that papers were excluded in a biased manner.

6.5 Generalizability of Findings

There is an urgent need for high quality synthesis of interventions practised in EDs to understand the impact that they may have in reducing overcrowding. The aim of evidence-based health practice is to incorporate the best evidence from research into the process of clinical and policy decision making.[100] This review provides a comprehensive evaluation of the controlled interventions that have been attempted in EDs. The variety of settings and ED practice conditions described in the included

studies contributes to the generalizability of findings across sites or organizations with varying characteristics.

It is important to place these results in context, and explore what "best practices" have been used to deal with ED overcrowding in Canada. Among Canadian ED directors who responded to a national survey on ED overcrowding, 40% indicated that they have implemented interventions to address the problem. Directors reported using a variety of interventions, many of which are supported by scientific literature. Results from a survey of 158 Canadian ED directors have shown that a variety of interventions have been implemented, such as fast track systems (62%), computerized patient-tracking systems (37%), and triage-scoring systems (99.3%).[18] Ambulance diversion policies have also been instituted to control overcrowding (42.2%). Ambulance diversion is unavailable in 27.1% of the EDs that were surveyed, because they are the only local EDs where ambulances can present, or because a provincial policy prevents them from diverting (e.g., Québec). The implementation of administrative action plans to deal with diversion were reported by 36% of ED directors; 75% of them said that their current policy was either minimally effective or not effective in reducing overcrowding. ED directors report using interventions for which evidence is inconclusive, such as physician order entry and triage. While triage is an important process to prioritize ED care when the ED is overcrowded, its influence on overcrowding is inconclusive.

Table 1: Evidence-based interventions for ED overcrowding and clinical practice

Intervention	Systematic Review	ED Survey	Evidence
Fast track	✓	✓	++
Triage	✓	✓	inconclusive
Diversion strategies	✓	✓	+
Short stay units	✓	✓	+
Staffing changes	✓	✓	+
Physician order entry	✓	×	inconclusive
Specific processes: electronic tracking board, re-engineering of ED radiology services, admission system based on telephone consultation between ED physicians and in-house hospital staff, point-of-care testing, dedicated stat laboratory, implementing a satellite laboratory and research nurse in the ED for point-of-care testing, alternative care destination program, bedside registration	✓	×	+
Multi-faceted interventions: increased emergency physician coverage; designation of physician coordinators; new hospital policies regarding laboratory, consultation, and admission procedures	✓	✓	+
Interventions used by ED directors for which there is no evidence: float nurse pool, senior ED MD flow shift, home care and community care workers assigned on site to ED, over-census on wards ("hallway" patients), establishment of orphan clinics, "coloured" codes to decongest ED, emergency in-patient (EIP) units	×	✓	N/A

✓=reported in scientific literature; ×=not reported in scientific literature; ++=scientific evidence from RCTs supporting intervention; +=scientific evidence from non-randomized studies supporting intervention; N/A=not available.

Other specific processes described in the scientific literature do not seem to have been adopted in EDs across Canada (Table 1). The need is urgent to assess the effectiveness of all interventions, especially those identified largely in the grey literature.

Results from this review will increase understanding about the effectiveness that some of these interventions may have on the problems associated with ED overcrowding in settings across Canada.

6.6 Health Services Impact

The CAEP and NENA have called on the federal government to address the problem of overcrowding in a comprehensive way, with a focus on the patient. What impact this may have on health services in Canada is unclear. A 2001 review of ED overcrowding in Massachusetts concluded that several steps must be taken to adequately assess the demands on health care resources and address the problem. This includes monitoring the number of occupied beds, monitoring the number of urgent versus non-urgent admissions, and observing seasonal fluctuations in the need for services. It also recommended that a real-time monitoring of ED saturation status be made available.[101]

To establish national standards for emergency services, hospitals will need to invest in information technology, so that EDs can collect relevant data and performance indicators, and benchmarks can be developed. There will also need to be system-wide collaboration involving EDs, and regional and provincial governments.

6.7 Knowledge Gaps

Using the results of this study to guide decision making to reduce ED overcrowding will require knowledge about the systems where the interventions have been used successfully. For example, the use of a fast track system varies among Canadian EDs, with systems ranging from an intermittent, part-time operation in a non-dedicated area located in the main ED with variable staffing, to a separate, fast track area with dedicated staff, and consistent and extensive operational hours.[15] The survey of 158 ED directors from across Canada[18] found that 62% of EDs had a fast track system, but there is little reporting about the success of these interventions in the scientific literature.

It is not only interventions that will help to reduce ED overcrowding. "Early warning indicators" can help hospitals address the problem by signalling when the ED is approaching overcapacity.[9] As a previous systematic review on measures to document ED overcrowding has concluded,[24] proxy measures for overcrowding or other "indicators" that may help to signal impending overcrowding are multi-faceted. Many EDs are incapable of easily reporting, and hence responding to, ED overcrowding indicators, and there may not be any single appropriate indicator across EDs. A consistent application of early warning indicators requires an accepted definition of ED overcrowding, which is lacking in Canada.

7 CONCLUSIONS

The literature reviewed in this report reveals that many interventions of varying complexity, intensity, and duration have been applied in an attempt to address the issue of ED overcrowding. Most of these interventions have demonstrated a positive change in the outcome measured. We cannot determine the relative value of interventions, and the lack of comparison studies of different interventions precludes a comment on superiority. Most interventions generate a moderate to large treatment effect. These results suggest that efforts to address overcrowding at an institutional level should be encouraged and monitored, because they have a high chance of success. Furthermore, the results support current efforts to promote multi-component interventions based on a full understanding of the process of care in the ED.

More studies are needed on the specific effects of a variety of interventions, and how they might affect the quality of care and patients' outcomes in the ED. Better reporting on setting characteristics, study design, treatment description, and outcome measures will increase our understanding of which interventions will work best to reduce overcrowding in the ED settings in Canada.

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APPENDICES

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