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Systematic review of triage-related interventions to improve patient flow in emergency departments

Noeer Fahes Alenezi[1*], Hela Freah Alenezi[2], Hind Suleman Alenazi[3], Abdulrahman Eid Alsuaibi[4], Hattan Mohammed Khushaim[5], Khalil Ibrahim Shubayli[6], Hana Doughim Almutairi[7]

[1] Corresponding Author, Staff Nursing, Alrabea PHC, Riyadh, SA
[2] Staff Nurse, Chest Disease Center in Qurtubah, Riyadh, SA
[3] Staff Nurse, Granada Health Center, Riyadh, SA
[4] Radiology technician II, Radiology Dept., KFMC, Riyadh, SA
[5] Radiology Specialist, Radiology Dept., KFMC, Riyadh, SA
[6] Radiology Specialist II, Radiology Dept., KFMC, Riyadh, SA
[7] Phlebotomist, PCLMA, KFMC, Riyadh, SA

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Abstract: **A systematic literature review was undertaken to scientifically explore which interventions improve patient flow in emergency departments. Studies were excluded if they did not present data on waiting time, length of stay, patients leaving the emergency department without being seen or other flow parameters based on a non-selected material of patients. Results: The interventions were grouped into streaming, fast track, team triage, point-of-care testing (performing laboratory analysis in the emergency department), and nurse-requested Scientific evidence on the effect of fast track on waiting time, length of stay, and left without being seen was moderately strong. The effect of team triage on left without being seen was relatively strong, but the evidence for all other interventions was limited or insufficient. Conclusions: Introducing fast track for patients with less severe symptoms results in shorter waiting time, shorter length of stay, and fewer patients leaving without being seen. Team triage, with a physician in the team, will probably result in shorter waiting time and shorter length of stay and most likely in fewer patients leaving without being seen. There is only limited scientific evidence that streaming of patients into different tracks, performing laboratory analysis in the emergency department or having nurses to request certain x-rays results in shorter waiting time and length of stay.**

Keywords: **Patient flow, Emergency departments.**

1. BACKGROUND

Overcrowding in the emergency department (ED) is a growing global problem [1]. In the United States, a committee of the Institute of Medicine called emergency department overcrowding a national crisis [2]. Overcrowding in emergency departments also affects patient safety and timeliness (time required for appropriate treatment) [3], threatens patient privacy and confidentiality, and often leads to frustration among emergency department staff [4-12]. Many factors determine patient flow in emergency departments [13, 14] and the conceptual input-flow-output model has become an accepted approach to understanding the causes of overload [3,15,16]. Depending on the model, causes can be looked for in one of three areas, and actions to reduce overcrowding can be directed toward the entrance, flow, or exit of the ED. Although some of the proposed solutions to improve patient flow in the emergency department are from systematic reviews, many of the improvements are of a special nature [17]. Many of 's new strategies are inspired by lean healthcare thinking with a focus on directing flows, reducing unnecessary work items, continuous quality improvement, and involving customers. all colleagues [18-20]. Despite efforts, scientific knowledge remains limited regarding practical strategies and approaches to improve patient flow in emergency departments. The American Academy of Emergency Medicine recently released a statement concluding "it is currently unclear which strategy offers the best solution to correct flow in the emergency room" [1]. In recent years, health authorities in many countries have introduced standards, with or without economic incentives, to reduce hospital stays in the emergency department [21]. The best known is the 4-hour target set by the National Health Service (NHS) in the UK [22]. The purpose of this review was to identify and evaluate the scientific evidence on various interventions aimed at improving patient flow in emergency departments. In 2010, the Swedish Medical Technology Review Board (SBU), a government agency, presented a systematic literature review that explored the scientific basis for various interventions. to improve patient flow in the emergency room. This assessment is based on data from that report [23].

2. METHODS

A systematic search of international literature published between 1966 and 31 March 2009 was performed on the British Nursing Index, Business Source Premier, CINAHL, Cochrane Library, EMBASE, ProQuest ABI, PubMed and Science Direct (for search strategies see Supplementary File 1). . The database search was complemented by a thorough review of reference lists and review articles. Inclusion of articles was limited to studies involving adult patients (aged 15 years) presenting to the emergency department for physical reasons. To include , studies had to report waiting time (WT) data, i.e. Time from arrival to the emergency room until being seen by a physician, length of stay (LOS), i.e. total time spent in the emergency department, not seen (LWBS), i.e. percentage of patients leaving out of the emergency room without being seen by the physician or other flow parameters based on unselected patient documentation. Studies were included only if they had a control group, in a randomized controlled trial, or in an observational study of historical controlled people. The quality of all studies was reviewed using validated checklists for internal validity, accuracy, and applicability (external validity) [24,25]. The methodological quality and clinical relevance of each study were classified as high, moderate, or low. Two independent experts performed the blinded review, and studies were included only if both experts considered the study relevant. To reduce inter-professional differences, standardized samples were used. The second step is to use the internationally developed GRADE system to provide an overall assessment of the scientific evidence that underlies the report's conclusions [26]. The following factors were considered when assessing the overall strength of the evidence: study quality, relevance/consistency, transferability/relevance, data accuracy, risk of publication bias, scale of impact, and dose response. Predefined instructions for upgrading and downgrading were used to achieve which is the final score showing the strength of the proof [26]. Lower the limitations reflected in study design or performance, inaccurate estimates, variability of results, indirectness of evidence, or publication bias. The upscaling reflects the large effect scale, dose-response gradient, and data consistency. Based on these rules, each conclusion is rated as having strong, moderately strong, limited, or incomplete scientific evidence. In the scoring process, studies of low quality and relevance were included while no studies of medium quality and relevance were absent.

3. RESULTS

Desk research, selection process and outcome measurement. The initial search identified 1,218 abstracts that were rated for relevance. Fifty-four articles were considered potentially relevant and were evaluated in their entirety. In addition, 36 articles were found by "snowballing", i.e. through reference lists and other sources. In the end, 33 articles were selected.

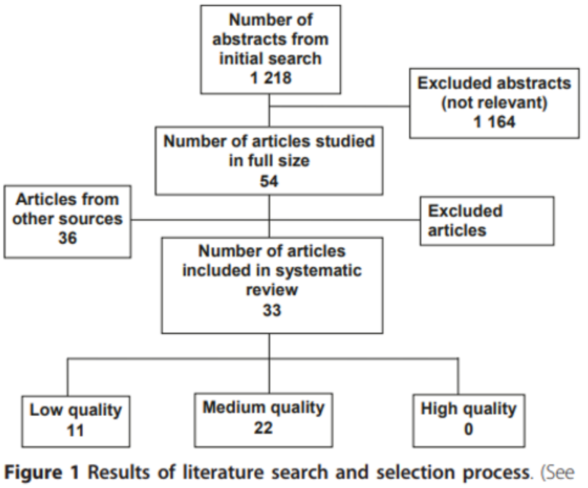

Figure 1 Results of literature search and selection process. (See separate file).

Final selection was based on relevance, eligibility, and study design (Figure 1). Of these, none achieved high-quality, 22 medium-quality, and 11 low-quality. The two most common outcome measures were WT (16 studies) and length of stay (23 studies). Reports of LVBS are less common (11 studies). Notably, none of the studies reported indicators of patient safety or cost-benefit. The final selected articles were divided into five groups, where each group represented a specific type of intervention used to improve patient flow in the emergency department. Interventions were performed in person, fast-tracked, grouped, point-of-care testing and x-rays as ordered by the nurse.

Streaming

Streaming refers to routines where patients, following triage or brief evaluation, are divided into different processes (streams) according to defined criteria. The most common example of streaming involves the use of a separate process, usually called fast track, to handle patients with less serious symptoms. Of the 16 studies on streaming that fulfilled the inclusion criteria [27-42], 13 focused on fast track and are reported separately (see below). Two of these studies separated patients into two processes (streams); patients who would benefit from admission and those who could be treated as outpatients [40,41]. However, LOS in the ED was reduced in both streams. Kelly et al reported reduced WT and shorter LOS for patients in 2 of 5 triage levels. The third study divided patients of all categories into two streams where patients were cared for by two teams of physicians and nurses [42]. Based on these studies, the scientific evidence for streaming, not including fast track, is limited (Table 1). Fast track Thirteen studies described the effects of fast track on patient flow in the ED [27-39].

Table 1 Evaluation of scientific evidence of streaming according to GRADE

Outcome measures	Number of patients (number of studies)	Study design	Outcome*, median (min-max)	Scientific evidence according to GRADE	Comments
Waiting time (shorter)	240 429 (3 studies)	Observational studies	31 (14-48) min	Limited ⊕⊕	Upgraded because of study quality. Downgraded because of outcome size
Length of stay (shorter)	141 017 (2 studies)	Observational studies	9.5 (0-11) min	Limited ⊕⊕	Downgraded because of study quality. Upgraded because of outcome size.

* Outcome calculated as the difference between intervention and control

During days without fast track, suitable patients were registered and used as controls. A study in New Zealand evaluated and treated patients with less complicated problems via a separate process named the Rapid Assessment Clinic (RAC) during odd weeks [33]. WT and LOS were reduced for patients in triage levels 4 and 5. The study indicated no effect on patients in the other triage levels. In 2008, an Australian cohort study with 20,000 patients in each group (with or without fast track) demonstrated significantly shorter WT with fast track [30]. Another Australian study selected 33% of all patients to be treated by a senior physician in a fast-track model [38]. In a third study from Australia, O'Brien et al demonstrated reduced WT by 20% and reduced LOS by 18% for nonadmitted, fast track patients [35]. For patients that were eventually admitted, WT and LOS in the ED remained unchanged. The largest study, an observational study originating from Spain, compared 71,000 fast track patients with an equally large control group [36]. Despite a 4.4% increase in attendance during the fast-track period, WT was 50% shorter and LOS 10% shorter for the total patient population, when fast track was introduced. Another seven smaller studies also demonstrated significant effects of fast track. In conclusion, all 13 studies demonstrated positive effects on WT and LOS when fast track was implemented.

Table 2 Evaluation of scientific evidence of fast track according to GRADE

Outcome measures	Number of patients (number of studies)	Study design	Outcome*, median (min-max)	Scientific evidence according to GRADE	Comments
Waiting time (shorter)	>90 000 (9 studies)	1 RCT 8 observational studies	24.5 (2-51) min	Moderately strong ⊕⊕⊕	Upgraded because of outcome size and concordance of data
Length of stay (shorter)	>100 000 (10 studies)	2 RCT 8 observational studies	27 (4-74) min	Moderately strong ⊕⊕⊕	Upgraded because of outcome size and concordance of data
Number of patients leaving ED without being seen by a physician (fewer)	>90 000 (5 studies)	No RCT 5 observational studies	3.1 (0.2-4.1) percent	Moderately strong ⊕⊕⊕	Upgraded because of outcome size and concordance of data
Patient satisfaction (increased)	447 (2 studies)	1 RCT 1 observational study	-	Insufficient ⊕	Downgraded because of study quality, imprecise data and low reproducibility

* Outcome calculated as the difference between intervention and control for all patients or for patients leaving the ED if data is missing for all patients. If results only are presented per triage group calculations are made for triage group 4.

A quasi-randomized study from Canada with 6,000 patients evaluated the effect of a triage liaison physician on LOS and LWBS [43]. The liaison physician facilitated patient flow by supporting the triage nurse, evaluating ambulance patients, initiating the diagnostic procedure, and handling administrative questions. Total LOS was reduced by 11% and LWBS was reduced by 20%. In a study from Northern Ireland, Subash et al randomized approximately 1,000 patients to team triage or ordinary triage [44]. However, no reduction in total LOS could be demonstrated. In a study from the United States, Partovi et al investigated the effect of a senior emergency physician in the triage team and reported that total LOS decreased by 82 minutes on average [47]. An Australian study with over 10,000 patients evaluated the effect of a Rapid Assessment Team (RAT) consisting of a physician and a registered nurse [48]. Based on the reviewed studies, we conclude that limited evidence suggests an effect of team triage on patient flow as measured by WT and LOS. However, relatively strong evidence suggests that team triage reduces the number of patients leaving the ED without being seen by a physician (Table 3).

Table 3 Evaluation of scientific evidence of team triage according to GRADE

Outcome measures	Number of patients (number of studies)	Study design	Outcome*, median (min-max)	Scientific evidence according to GRADE	Comments
Number of patients leaving ED without being seen by a physician (fewer)	32 830 (4 studies)	1 RCT 3 observational studies	1.3 (1.2-6.8) percent	Moderately strong ⊕⊕⊕	Upgraded because of concordance of data
Waiting time (shorter)	25 927 (3 studies)	No RCT 3 observational studies	18 (16-20) min	Limited ⊕⊕	Downgraded because of study quality and heterogeneity
Length of stay (shorter)	29 674 (4 studies)	2 RCT 2 observational studies	40.5 (0-55) min	Limited ⊕⊕	Upgraded because of outcome size. Downgraded because of study quality.

* Outcome calculated as the difference between intervention and control

Point-of-care testing

A randomized study from Canada demonstrated shorter LOS when laboratory analyses were performed at the ED, especially for nonadmitted patients [50]. Another randomized study with 800 patients demonstrated significant changes in management, but no effect on LOS or admission rates [49]. In a US study, Lee-Lewandrowski et al found shorter turnaround time (i.e. the time from ordering laboratory tests to the results being available for the attending physician) and shorter LOS with POCT [51]. The study demonstrated high satisfaction among the staff. The selection of laboratory tests available as POCT has a substantial impact on the results. In a US study by Parvin et al, almost 95% of the patients also needed centra laboratory analyses to complement POCT. Based on the studies assessed, the effect of POCT on turnaround time is supported by relatively strong evidence, whereas its effect on LOS is supported by only limited evidence (Table 4).

Table 4 Evaluation of scientific evidence of point of care testing according to GRADE

Outcome measures	Number of patients (number of studies)	Study design	Outcome*, median (min-max)	Scientific evidence according to GRADE	Comments
Response time (shorter)	12 273 (3 studies)	No RCT 3 observational studies	51 (51-51) min	Moderately strong ⊕⊕⊕	Downgraded because of study quality. Upgraded because of outcome size.
Length of stay (shorter)	18 401 (5 studies)	2 RCT 3 observational studies	21 (-8-54) min	Limited ⊕⊕	Downgraded because of low reproducibility and heterogeneity

* Outcome calculated as the difference between intervention and control

Nurse-requested x-ray

X-ray examination is another time-consuming process in the emergency room. To reduce waiting times, some hospitals have experimented with x-rays ordered by nurses. Of the three nurse-directed radiology studies included in this review, two were of moderate quality and one of low quality. All studies were randomized, in one case semi-randomized (Supplementary File 6) [55-57]. In a British study including 1800 patients, trained nurses were able to order X-ray examination of wounds below the elbow and knee [57]. There is no specific training provided to nurses and patients are classified as nurse first or doctor first by the nurse. In the group that was first seen by a nurse, the length of stay in the hospital was reduced for patients who did not need X-rays, while no difference was observed in the group who needed X-rays. Nurses ordered slightly more X-rays (4%) than doctors. In a study by Lindley-Jones et al., also in the UK, a nurse randomly assigned orthopedic patients

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with suspected fractures at the nurse's request or at the request of a physician or nurse practitioner practice [55]. The time to diagnosis was significantly shorter in the group requiring nurses. However, nearly 8% of patients did not receive the X-ray ordered by the nurse that was received after the examination by the doctor. In a quasi-randomized study in Australia, a triage nurse ordered X-rays on odd days and a physician ordered X-rays on even days [56]. The study only included patients with wrist or ankle injuries. The study reported no difference in ER length of stay between the groups. Based on these studies, scientific evidence for WT duration and/or shorter survival after nurse-ordered radiographs is considered limited (Table 5).

Table 5 Evaluation of scientific evidence of nurse-requested x-ray according to GRADE

Outcome measures	Number of patients (number of studies)	Study design	Outcome*, median (min-max)	Scientific evidence according to GRADE	Comments
Waiting time and/ or length of stay (shorter)	2 682 3 studies	RCT	10 (6-37) min	Limited ⊕⊕	Downgraded because of study quality, low reproducibility and heterogeneity

* Outcome calculated as the difference between intervention and control. Because of low numbers, waiting time and length of stay have been grouped together.

4. DISCUSSION

Of the five interventions addressed in this review, fast track demonstrates the best scientific evidence. In addition to improving patient flow, fast track would likely have benefits related to economics and patient satisfaction. Concerning ethics and patient safety, it is important to note that many studies clearly demonstrate that the introduction of fast track does not negatively affect treatment and waiting times of patients with more severe diseases and injuries. However, none of the studies in this review have evaluated patient safety outcome measures, e. mortality and need for treatment in an intensive care unit. Fast track for patients with uncomplicated diseases and injuries was introduced and evaluated in EDs of many countries already in the 1990s [58]. The main intention of fast track was to reduce the total number of patients staying in the ED, and thereby improve patient satisfaction and patient safety. Patients were usually selected for fast track based on the triage nurse's decision of appropriateness. The proportion of patients suitable for fast track varies between 10% and 30% of total patients seen in the ED [27,33,35]. Some studies have serious limitations resulting from wide variations in staffing and patient selection. Although such an approach can be tempting as an alternative to fast track, it raises warning signals about patient safety and patient satisfaction [62]. Some authors stress the importance of using a senior physician to staff the fast track [38]. Other studies, however, demonstrate positive effects when junior doctors [27] are engaged and when nurse practitioners manage fast track [31]. Patients selected for fast track should be able to manage without too many diagnostic procedures, e. laboratory tests and x-rays. Another important factor involves directing fast track patients to specific areas in the ED, separate from areas where patients with higher medical priorities are managed. Reduced WT and LOS were detected only among patients that could be discharged, which is in line with the positive results of fast track. Few relevant studies have been published on streaming other than fast track, limiting the chances of detecting strong evidence. The rationale for these new systems of process triage has been to improve patient flow and to increase patient safety, but this has yet to be verified in published studies. Although team triage has not been universally defined, it usually means that a team consisting of a physician and a nurse initially evaluates the patient. To avoid "bottle necks" it is important that the total handling time per patient is short, which indirectly defines the tasks of the team. With a physician present in the team, it has become increasingly common to add procedures, e. ordering laboratory tests and x-rays. In some studies, patients with minor complaints receive final treatment from the team, like the principle of fast track. Most authors agree that the team should focus on initiating and planning patient treatment, whereas final treatment should be referred to the ordinary staff. The advantage of team triage may be most significant in complex situations, whereas noncomplex patients are better handled by fast track. Most authors emphasize the importance of a senior physician in team triage [44,45]. The main effect of team triage appears to be that fewer patients leave the ED without being seen by a physician. Such an effect is not surprising given the presence of a physician in the triage team. The process of laboratory testing is usually complex and includes different steps, e. ordering, sampling, marking, transportation, analysis, reporting of results, interpretation, and informing the patient. Several interventions have been applied to shorten the process of laboratory testing, e. early ordering, predefined test panels based on symptoms and/or suspected diagnosis, limitations on tests that can be ordered from the ED, faster transportation to the laboratory, and faster reporting systems. As a consequence of technical advancements, the range of tests continues to expand, and thus the positive effect on LOS can be expected to increase in the future.Low precision will affect patient safety and hamper the effects on flow - at least in the long-term. In many cases, it is evident at first presentation that the patient needs an x-ray. One could expect that requesting x-ray examination early might reduce LOS. One of the studies [57] demonstrated shorter LOS for patients not needing x-ray, which again suggests that sorting out patients that require no further investigation has the greatest impact on patient flow [45]. Some of the interventions influence the entire process, i. team triage, fast track, and other forms of streaming, while others affect only certain parts of the process, i. POCT and nurse-requested x-ray. Fast track is the most studied intervention and the method supported by the strongest scientific evidence. However, it is reasonable to perceive additive, perhaps synergetic, effects between all the interventions described in this review, and a broad approach is most likely the way to success. Therefore, processes outside of the ED setting also need to be systematically reviewed and improved. Context-related factors and organizational placebo effects can play a stronger role than the intervention itself, often making it difficult to draw conclusions. Interventions may also have consequences on quality, patient and staff satisfaction, and economic and ethical issues, all of which must be taken into consideration. Consequently, further studies and new approaches are needed to fully evaluate the effects of organizational interventions. Conclusions Introducing fast track for patients with less severe symptoms results in shorter waiting time, shorter length of stay, and fewer patients leaving without being seen. Team triage, with a physician in the team, will probably result in shorter waiting time and shorter length of stay and most likely in fewer patients leaving without being seen. There is only limited scientific evidence that streaming of patients into different tracks, performing laboratory analysis in the emergency department or having nurses to request certain x-rays results in shorter waiting time or length of stay.

Authors' contributions

All authors participated in the design of the review. All authors read and approved the final manuscript.

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