

Overcrowding in emergency departments: A review of strategies to decrease future challenges

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Emergency departments (EDs) are the most challenging ward with respect to patient delay. The goal of this study is to present strategies that have proven to reduce delay and overcrowding in EDs. In this review article, initial electronic database search resulted in a total of 1006 articles. Thirty articles were included after reviewing full texts. Inclusion criteria were assessments of real patient flows and implementing strategies inside the hospitals. In this study, we discussed strategies of team triage, point-of-care testing, ideal ED patient journey models, streaming, and fast track. Patients might be directed to different streaming channels depending on clinical status and required practitioners. The most comprehensive strategy is ideal ED patient journey models, in which ten interrelated substrategies are provided. ED leaders should apply strategies that provide a continuous care process without deeply depending on external services.

Key words: Emergency department, overcrowding, patient flow, patient journey, patient safety

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INTRODUCTION

Overcrowding in emergency departments (EDs) is a concerning global problem and has been identified as a national crisis in some countries.^[1,2] Overcrowding of EDs is defined as "the situation in which ED function is impeded primarily because of the excessive number of patients waiting to be seen, undergoing assessment and treatment, or waiting for departure comparing to the physical or staffing capacity of the ED."^[3] Patients' safety and privacy,^[4,5] timeliness of the services,^[4] and frustration among ED staff^[6] should be considered in the studies of overcrowding in EDs.

Imbalances between the capacity of the ED and the demand for patient triage, diagnostic images, laboratory tests, and specialty consultations affect the patient flow

in ED.^[7,8] In addition, some studies have identified the effect of high occupancy (above 90%) and access block as causes of adverse patient outcomes, treatment delays, high mortality rates (20%–30%), prolonged inpatient length of stay (LOS), and hospital readmission.^[9-11] The high occupancy of the ED can also be explained by the majority (50%–75%) of patients get admitted to the hospitals through ED.^[12]

To alleviate the problem of ED overcrowding, different solutions are proposed by researchers such as input-throughput-output conceptual model of ED crowding,^[13] increasing the resources, demand management, operation research,^[11] lean thinking,^[14] chest pain observation units,^[15] rapid assessment zones,^[16] and clinical decision units.^[17] Lean health-care thinking led many of the new strategies with redesigning the optimal pathways, contributing value steps, and deleting nonvalue steps.^[18] Four-hour target has been

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introduced by health authorities to decrease the LOS in ED.^[19,20] Despite previous efforts, limited scientific knowledge on how to improve patient flow in ED has achieved.^[1]

The objective of this review article is to present strategies with an important role in the improvement of patient flow, delay in services, and overcrowding of the EDs.

MATERIALS AND METHODS

In this review article, we performed a computerized database search to identify relevant articles. We searched for published and ready-to-publish articles in bibliographic databases, including ISI Web of Science, PubMed, Science Direct, Scopus, Wiley online library, Google Scholar, and other governmental, national, and international databases and websites. In addition, the literature search also involved a manual search of bibliographies of the identified papers and relevant information to meet the objectives of this study. An extensive search of keywords used in the search were "Emergency Department (ED)," "Overcrowding," "Triage," "Patient Acuity," "Hospital Emergency Services," "Emergency Room/Ward," "length of Stay (LOS)," "Patient Navigation," "ED Patient journey," "ED Patient Flow," "Ambulance diversion," "Emergency Outpatient Unit," and "Patient Safety." Table 1 provides details on the specific search terms and combinations. The selection of these terms

Table 1: Result and keywords from each database

Database	Other Keywords	Results
ISI Web of Science	Patient flow, emergency care delivery, admission predictive tool, waiting times, ED under crowding, crowding measure, patient grouping, and prioritization	22
PubMed	Patient handoff, utilization of EDs, ED enlargement, triage processes, transfer of care, nonurgent visits redirection, fast track	334
Science direct	Capacity in EDs, emergency medicine, overcrowding strategies, overcrowding mitigation, complaints and violence in the ED	143
Scopus	Offload zone patient selection, patient transfer, ED referral, streamlined admission, overcrowding management, routes of admission in, ED treatment rooms assigning, capacity allocation in ED	427
Wiley online library	Patient disposition, clogging ED, access block, short-stay units in EDs, safe capacity in EDs, ED occupancy, emergency journey, delayed disposition, busy EDs	5
ISD	The length of stay, waiting time measurement	7
Google Scholar	Same as all the above keywords	68

EDs = Emergency departments

was made with the help of MeSH service in PubMed website databases.

Data extraction

Independent reviewers (FR and MHY) screened abstracts and titles for eligibility. When the reviewers felt that the abstract or title was potentially useful, full copies of the article were retrieved and considered for eligibility by both reviewers. When discrepancies occurred between reviewers, the reasons were identified, and a final decision was made based on a third reviewer (AH) agreement. STROBE scale was used to select the studies for this review.

Inclusion and exclusion criteria

For this review article, the literature limited to journal articles and governmental documents in English and Persian. The search included studies to 2016. The main reasons for exclusion were: (1) not assessing any real patient flow in EDs and (2) assessing patient flow outside the hospitals or specialized services of hospitals.

RESULTS

The initial electronic database search of the literature resulted in a total of 1006 articles [Figure 1]. Of these, 136 were selected as potential studies based on their titles and abstracts. After the complete article was read, however, only thirty of these actually fulfilled the inclusion criteria. One hundred and six papers were excluded after reading the complete article.

Key strategies in controlling overcrowding in EDs have been categorized in this study [Table 2]. Facilities can utilize each of them as follows:

Streaming in the patient journey

Predefined criteria for designing patients' flow after triage divide processes into different streams. The most typical streaming is called the fast track for handling patients with less serious symptoms.^[50]

Health-care processes before and after the ED visit are interrelated. Examples of processes before the ED are prehospital and primary care visit, and provision of hospital beds is an example of a process after the ED visit. Therefore, it is important to review and improve all the health-care-related processes during patient visit systematically. Moreover, it should be considered in studies and decision-makings that access to ED is an issue at a strategic government level, whereas throughput efficiencies are being addressed at a local operational level.^[51]

Strategies to manage throughput ED patient flow should focus on the following issues: Patient acuity levels, prolonged

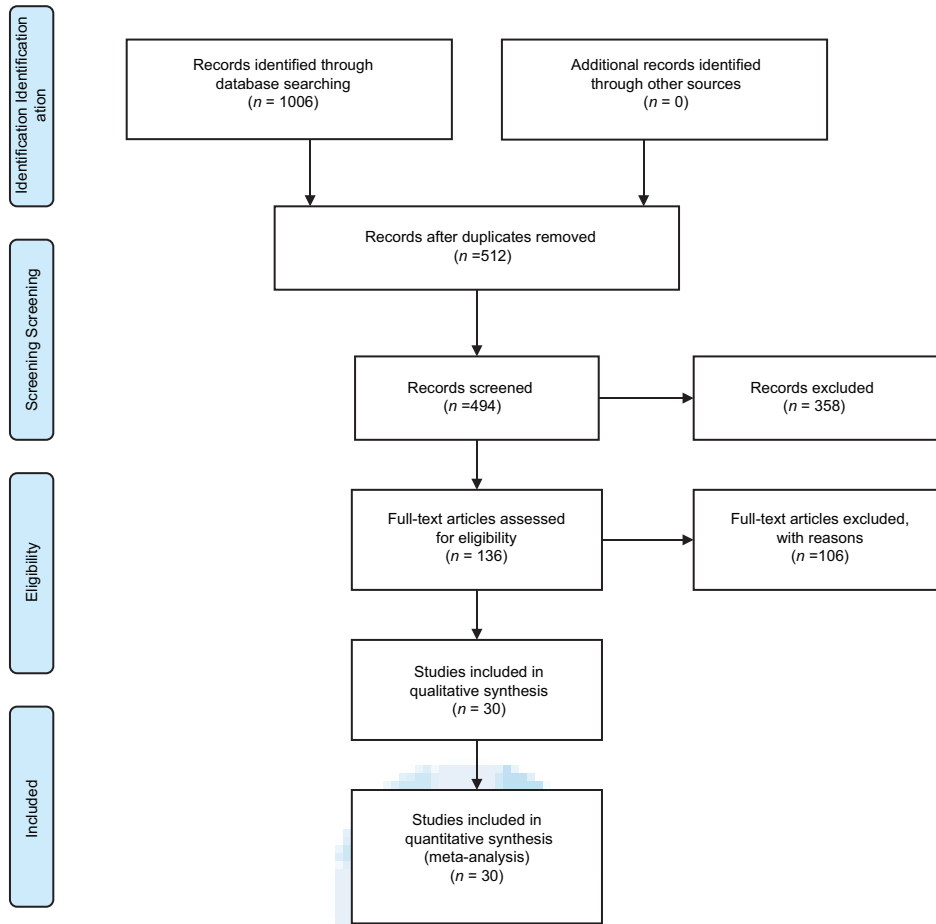


Figure 1: PRISMA 2009 Flow Diagram^[21]

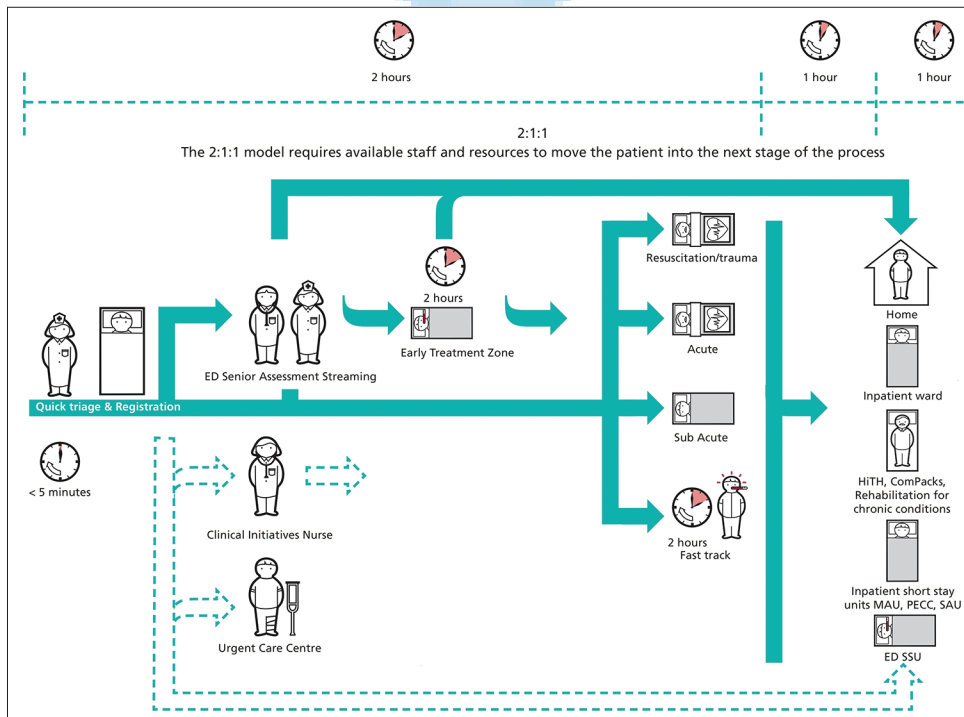


Figure 2: The ideal patient journey with streaming to models of care within emergency department and external to emergency department^[49]

Table 2: Description of strategies to overcome emergency department overcrowdings

Strategies	Patient characteristics	Responsible practitioners	Coverage	Advantages	Challenges
Streaming	For minor injuries, especially those patients discharged home ^[22]	ED clinicians	All patients	Reducing crowding Improve the efficiency Groups of patients co-located to discrete areas to provide care with resources according to patients' needs ^[23]	Streaming creates the potential for one stream to be under pressure with treatment delays while another is quiet ^[24] Misallocation of patients ^[25]
Fast track	Nonemergency patients with uncomplicated diseases ^[26,27]	Nurse practitioner and doctors ^[28]	10% and 30% of total patients are seen in the ED ^[29,30]	Reducing the total number of patients staying in the ED Improving patient satisfaction and patient safety Patients received high quality of care ^[28,31]	Usually more applicable during peak hours, i.e., not during nights ^[32]
Team triage	Most significant in complex situations	A team with administration of a senior physician/nurse, a nurse initially evaluates the patient (spot check) and a receptionist or a nurse assistant ^[24,33,34] /physician-MDRNSTAT ^{∗[35,36]} /TLPs [∗] role ^[37]	Not found	Increasing accuracy and efficiency in the initial process of patient evaluation ^[35] as all of the team members received the same information simultaneously, thereby allowing them to work in a more coordinated manner ^[38] Patient examinations and diagnostic measures would be initiated earlier ^[39] Reduce LOS [∗] for low-acuity patients ^[40] Improving teamwork within hospitals ^[34]	Handling time per patient is essential to define the tasks of a team indirectly Team triage is not implementable if sick patients are waiting at the expense of minor injuries and for 24 h because of the insufficient resources ^[24]
POCT/POC-US [∗]	For high-risk patients suspected to have HIV or other dangerous communicable disease/dyspnea patients whose laboratory, radiology and ultrasound tests were ordered by the ED ^[41-43]	POCT-trained nurses	About 30%-66% of all patients at an ED ^[8,44]	Improvement of nurses' ability to incorporate testing into their existing clinical care ^[45] Positive effects on LOS or waiting times ^[46,47]	Increased costs POCT effect only on patients discharged home, and no significant impact on patients admitted to hospital The limited impact can be expected if many patients need central laboratory analyses in addition to POC ^[48]
Ideal ED patient journey models (within EDs) ^[51]	Acute care of complex, nonambulatory, high-acuity patients Lower acuity, complex, nonambulatory patients Noncomplex, ambulatory patients	Early senior medical assessment Clinical initiatives nurse Clerical officer co-located with the triage nurse	Not found	Providing multiple MOC [∗] options to assess and treat patients Allowing local health facilities have access to appropriate MOC depending on their ED Ensuring tasks are performed by the provider who can most efficiently perform the task Eliminating duplication of processes Reducing unproductive waiting periods	A direct referral to another provider for those patients who need care, but do not require emergency care Mental health Dental Sexual assault without injuries requiring ED management Early pregnancy assessment service Palliative care Aged care assessment and rehabilitation Specialist referral (rooms or direct to inpatient ward) Hospital in the home and postacute care services Outpatient's clinic referral Urgent care center Medical assessment unit Surgical assessment unit Postoperative review patients Drug and alcohol patients Fracture reviews

[∗]MDRNSTAT = Physician–nurse supplementary team at triage; MOC = Models of emergency care; TLPs = Triage liaison physicians' role; POC-US = Point-of-care-ultrasonography; LOS = Length of stay; POCT = Point-of-care testing; EDs = Emergency departments

ED evaluations, inadequate inpatient bed capacity, shortage of staff, problems with access to on-call specialists, and the use of ED by those who have no alternative medical care, such as the uninsured patients.^[52]

Fast track

Many hospitals have developed their own priority for providing fast track care, such as superficial wounds, nonsevere allergic reactions, fractures and distortions of small joints and bones, dog and cat bites, and minor burns.^[26]

Team triage

Physician–nurse supplementary triage assistance team (MDRNSTAT) is considered to be more cost-effective than team triage during time periods with higher patient volume.^[35] On the other hand, triage liaison physicians' (TLPs) role also proposes throughput factors contributed to ED overcrowding. The TLP's role is to work with triage staff to expedite the care of patients based on their medical needs, especially for those with unpredictable waiting times.^[37,53]

Development of triage systems

Medical Emergency Triage and Treatment System protocol in Sweden determines priority level based on the combination of vital parameters, symptoms, and signs, which are closely related to hospital LOS.^[54] Other common models in Sweden are the Adaptive Process Triage or nurse/emergency physician triage and the Manchester Triage Scale or nurse/junior triage.^[55] The reason for applying these new systems is an improvement in patient flow and increasing patient safety.^[50] Kelen *et al.* introduced "Reverse Triage" as a system for safe early discharge of hospital inpatients to create additional inpatient capacity.^[56] Telephone triage system is also a way of after-hours care in EDs, ambulance, and general practice services.^[57]

Point-of-care testing

In theory, similar to lean thinking strategy, this tool eliminates some of the most problematic steps in the testing process, such as specimen transport and result distribution.^[58] The Centers for Disease Control and Prevention introduced strategies to make HIV testing a routine part of health care by promoting simplified procedures to make testing more practical.^[43] To reduce wait time of laboratory testing, the following interventions have been proposed: early ordering, predefined test panels based on symptoms, faster transportation to the laboratory, and faster reporting systems and point-of-care-testing (POCT).^[50] Introducing POCT to the ED has significantly decreased turnaround time for the laboratory analyses which involve moving analytical instruments to the ED.^[59]

Nurse-requested X-ray

This diagnostic procedure is another time-consuming process in the ED. To overcome waiting time, nurse-requested X-ray has piloted in some hospitals.^[50]

Ideal emergency department patient journey models

The emphasis of the care is to stream patients into the most appropriate care model as early as possible. A set of possible [Figure 2] ED processes developed by New South Wales are summarized below:

- Triage and registration, clinical initiatives nurse, resuscitation (including trauma), acute care, early ED senior assessment and streaming, early treatment zone, fast track, subacute, 2:1:1, and ED short-stay units [Figure 1]
- This strategy provides an overview of models of care outside the ED that can support patient flow and provide timely access to acute care services: Medical assessment unit, surgical assessment unit, a hospital in the home, and psychiatric emergency care center services
- This strategy provides an overview of community models of care that provide access to unscheduled ambulatory care: Urgent care center, health direct Australia advice line, connecting care, and after-hours general practitioner clinic.

DISCUSSION

We need to consider the various aspects of overcrowding to overcome the emerging challenges. Overcrowding is associated with increased mortality, misplacing patients in an incorrect ward, delays in the initiation of critical cares (such as the administration of antibiotics in sepsis), longer physician waiting times, access block, decreased patient safety, decreased inpatient bed capacity due to high inpatient bed occupancy, and inefficient inpatient flow within the ED because of unnecessary peaks in demand for inpatient beds for elective surgery.^[11,60-63]

Several interventions have been proposed to alleviate ED overcrowding in all the three levels of input, throughput, and output: Input (e.g., ambulance diversion), through-put (e.g., rapid assessment zones/pods, and clinical decision units), and output (e.g., full-capacity protocols, bed managers). The last two interventions will improve output for admitted patients, but these are not completely under the control of ED leaders and require system-wide interventions.^[53] However, it is important to know that delay in patient flow during throughput phase has a significant influence on overcrowding. We considered contingency strategies during throughput phase and discussed them in the following section.

The main effect of team triage strategy would be fewer patients leaving without being visited by a practitioner.

Another positive effect is streaming patients more rapidly.^[50] Wang and Vikram's research has shown that presence of a family medicine resident physician in ED is associated with reduced waiting time and patients leaving without being seen.^[64] Hence, the team triage strategy through the participation of a physician as the leader could be one of the benchmarks.

Another effective intervention that has been appeared to be helpful in reducing the LOS, especially in injury and/or suspected fracture cases requiring radiography, is triage nurse ordering.^[65]

There are different types of alternative short-stay units including fast track, ambulatory areas, see and treat services, minor injury units, and rapid intervention and treatment zones. Numerous studies have shown that these units can effectively reduce mortality, the LOS, and access block, as well as improve staff and patient satisfaction.^[51]

Among strategies discussed in this study, fast track is proven to have scientific evidence as many studies illustrated that fast track not negatively effects on treatments of patients with the more severe emergency condition. In addition, fast track would likely have financial benefits and higher patient satisfaction (e.g., shorter waiting time, shorter LOS, and fewer patients leaving without being seen). However, further studies are required to evaluate ethics and patient safety of these interventions. The presence of a senior physician, a junior doctor, or nurse practitioner to manage fast track has been recommended in previous studies. Patient selection is another issue for the fast track as patients should be managed without too many diagnostic procedures, for example, laboratory tests and diagnostic images. Moreover, the fast track should be separated from areas where acute patients with severe medical condition are managed.^[66-68]

For paramedical services, laboratory examination of patients is another challenge in EDs. Directing patients to the laboratory testing stream is complex and time-consuming.^[69] This process has different steps, such as ordering, sampling, marking, transportation, analysis, reporting of results, interpretations, and informing patients.^[58] The laboratory testing stream increases the LOS in the ED about 80 min.^[70] The range of tests also effects on waiting time and LOS.^[62] Technical advancements expand the range of tests, which can decrease the LOS in the future.^[71] In addition, it is necessary to consider and evaluate the prerequisites for quality management and reliability of every method. Low precision affects patient safety and leads to adverse events.^[58]

There are other strategies that do not meet our eligibility criteria such as implementing outside the hospital or having

simulation-based concepts. We will discuss some of the most widely used strategies.

Alternative care facilities

This strategy has been applied increasingly in many countries. Uncomplicated patients are referred to primary health-care centers outside the hospital such as ambulatory care facilities,^[72] considering surge capacity as a contingency approach that will improve accessibility, reduce waiting time, lower costs, and improve patient outcome, staff satisfaction, and customer experience.^[52]

Overcrowding hazard scale model

This model includes statistics variables that are used to anticipate hazard ratio in future: Age (more than 50 years), transport (ambulance vs. nonambulance), diagnosis (illness vs. injury), Australasian Triage Scale Urgency Category 1 (resuscitation vs. less-urgent categories of 3, 4, and 5), Australasian Triage Scale Category 2 (emergency vs. less-urgent categories of 3, 4, and 5), overcrowding hazard scale (multiplying the hospital occupancy score and the ED access block occupancy score), and referral practitioners (physician vs. nonmedical). This strategy can be used to monitor the overcrowding hazards in actual time.^[9] Simulation of patient flow in ED is helpful to anticipate the near-future operating conditions with variables such as waiting count, waiting time, occupancy level, the LOS, boarding count, boarding time, and ambulance diversion.^[73]

Strategies for patient flow after ED should direct limitations as follows: lack beds, insufficient access to inpatient beds, inflexible paper-based systems, isolation precautions, cleaning delays, over-reliance on Intensive Care Units, high bed dependency, and inefficient diagnostics with delays in discharging hospitalized patients.^[13] In this study, we focus more on input and throughput strategies.

Emergency medicine ward

Populations under coverage of these facilities in a region are provided custom-made services. The focus is on patients who can be managed within 24–48 h of in-patient stay. Services are delivered interdepartmentally through interdisciplinary collaboration and consultation. After the rapid assessment, patients are referred to the next level of care such as community nurse service or a geriatric team. Emergency specialists round wards and perform four to six rounds per day.^[74]

It is important to consider the synergetic effects of all the interventions described in this review as the effect of an intervention is not isolated, especially because of interference with organizational issues. Local context, organizational factors, and cost-effectiveness analysis

of ED models necessitate additional methodological approaches with a sharper focus on outcomes of quality, patient and staff satisfaction, and economic and ethical issues.^[51] Strategies for managing throughput ED patient flow should focus on the following issues: patient acuity levels, prolonged ED evaluations, inadequate inpatient bed capacity, a severe shortage of staff, problems with access to on-call specialists, and the use of ED by those with no other alternative to medical care, such as the uninsured.^[52] Consequently, further studies must employ a systematic approach to evaluating the most likely way to success. Lean thinking, in which continuous improvement in all parts of processes is considered, would be helpful in this field of study.

Limitation

Only articles in English and Persian were included. Information bias is possible to occur in the field of misclassification of main concepts. In addition, selection bias could be considered in the field of publication bias within studies, especially nonaccessible governmental reports and books.

CONCLUSION

Overcrowding in hospitals is a complex phenomenon. The quality of services in EDs depends on coordinated efforts between emergency physicians, on-call specialists, emergency nurses, other health professionals, laboratory, diagnostic imaging services, and inpatient units. If any of these interdependent components disrupts the processes, health care would counter with difficulty. ED leaders can control some of these components. However, many components are controlled by stakeholders outside the ED whose priority may not be optimizing patient care in the ED. Thus, the ED may experience poor communication with laboratory and imaging services, restricted access to inpatient beds. ED leaders must focus on discussion meeting with institutional executives, internal and external stakeholders, and public policymakers to implement initiatives to ease ED crowding.^[75]

In addition, economic incentives of high occupancy, aging population phenomenon in developed countries, and not predicting emergency demands to optimize capacity may cause overcrowding. Solutions could be a realignment of financial incentives, considering misuse and overuse of health services, and improved chronic disease management to reduce hospital bed demand.^[76-78]

Although various models of care have been invented these days, understanding how and which models could be implemented in which organization requires further

researches. Keeping challenges and advantages of each model help us choose the correct way.

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Conflicts of interest

There are no conflicts of interest.

AUTHORS' CONTRIBUTION

FR and MHY contributed in the conception of the work, conducting the study, revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work. NT and AH contributed in the conception of the work, drafting and revising the draft, approval of the final version of the manuscript, and agreed for all aspects of the work.

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