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Development of an Emergency Department Trigger Tool

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Abstract

Background: Patient safety remains a critical concern for healthcare systems, particularly in developed nations. A substantial proportion of patients experience complications and adverse events attributable to healthcare delivery, exacerbating their initial health issues. Many adverse events are likely to go unnoticed, unreported, and consequently unaddressed. This issue largely stems from inadequate surveillance methods that require significant improvement to achieve excellence in delivering safe, high-quality care for emergency patients.

Objectives: This study aimed to develop an emergency department trigger tool (EDTT) to identify adverse events in the emergency department (ED) to enhance patient safety and quality improvement.

Methods: Conducted under the supervision of Mashhad University of Medical Sciences, this study comprised four stages: (1) a systematic review, (2) refinement and automation of empirical triggers, (3) a modified Delphi process to compile a list of validated triggers from experts, and (4) final environmental data collection to determine the most effective triggers.

Results: The study included a systematic review of electronic resources, revealing no prior Persian equivalent of a trigger tool. A total of 502 articles were identified in PubMed, 100 in Google Scholar, and 410 in Scopus. After removing duplicates and adding four articles based on reference searches, 1,016 article titles were initially reviewed. Two independent researchers evaluated the articles on the same day in two locations. In cases of disagreement, a third researcher's opinion was sought. Ultimately, 295 articles were selected, with high inter-rater reliability (0.82). Forty-two articles were included in the final analysis. The developed tool contained 50 triggers organized into six groups. In a review of 100 ED cases, an average of 1.2 triggers was identified per patient file, with 99 (79.8%) of these triggers attributed to medical errors.

Conclusion: This study successfully designed an emergency department trigger tool (EDTT) utilizing a systematic review and the Delphi method. The resulting trigger tool can be employed to assess high-risk situations and potential emergency medical errors. A significant advantage of this tool over previous versions is its focus on high-risk conditions without relying solely on the absence of appropriate actions as indicators of danger.

Keywords: Emergency Department, Trigger tool, Patient safety, Medical error

1. Background

Patient safety is one of the most important issues for health systems, especially in developed countries. Statistics show that a significant percentage of patients in the face of health systems, especially hospitals, suffer from complications and injuries caused by the healthcare systems, adding to their initial problems. The term safety culture was first coined during the Chernobyl accident in 1988. Since then, the concept has been used by many organizations, especially high-risk organizations, to improve safety. (1-5). However, there are no

systemic activities or responses to reduce these cases, especially in developing countries (6-8). Therefore, the World Health Organization and other leading organizations in this regard create a comprehensive systemic system based on patient safety promotion processes to reduce these complications and appropriate responses to injured people (9-11).

With the advancement of knowledge and technology in recent decades, healthcare services provision has become more complex (12-15). So, the likelihood of medical error risk has increased, and empirical evidence shows that the number of patients who suffer from medical error-related complications cannot be ignored. Therefore, patient safety is considered a vital issue in the health systems of different countries. The seven-step patient safety model has been used as a structural model to create a safer environment for providing safety services in the health care system (16-20).

The biggest challenge to moving towards a healthier and safer system is to change the prevailing culture of healthcare providers so that instead of blaming people for making mistakes and treating mistakes as individual failures, organizations should try to investigate the errors that occurred (21-24). This approach will improve the system and prevent damage. Since patient safety culture is a factor in the formation of staff performance and affects the behaviors of healthcare providers, it causes them to consider maintaining and promoting patient safety as one of their highest priorities in providing healthcare (25-28). It is vital to find errors before occurrence, and this needs to develop an accurate device that can recognize risky situations.

Trigger Tool was first introduced by the Institute for Healthcare Improvement (IHI). In 2009, a revised version was developed for the emergency, surgery, pediatric, and intensive care units. The primary purpose of designing this tool was to identify common hazards and errors that occurred without a detailed review of medical files and reduce file review time with an acceptable accuracy (28-32). The estimated time to review each file with this tool is 20 minutes. If the researcher has identified a trigger in the patient's file, he or she should investigate whether an error has occurred. Some of the triggers associated with the global trigger tool were spontaneous errors, such as the occurrence of nosocomial pneumonia. In many cases, triggers may be found in the file without error (32-36).

In studies conducted in the United States and Europe, the Trigger tool has been used experimentally to detect unwanted events. Its sensitivity and specificity, as well as the positive predictive value. However, there is no particular tool for evaluating health care in the emergency department. ED is a crucial and risky unit because of its overcrowding and staff shortage in our country. So, we aimed to develop an emergency department trigger tool (EDTT) to identify adverse events for improving patient safety and quality improvement.

2. Objectives

This study aimed to develop an emergency department trigger tool (EDTT) to identify adverse events in the emergency department (ED) to enhance patient safety and quality improvement.

3. Methods

This study was conducted in four stages:

1. A systematic review was performed to find emergency department triggers in electronic resources. The IHI Global Trigger Tool has only two ED-related items (readmission to the ED within 48 hours and ED stay longer than 6 hours). Griffey developed an ED-specific trigger tool in 2016. We designed our study based on his report and trigger tool. Studies described error markers or triggers in the ED were included in our study. We excluded letters and articles without original data that are purely theorizing.

Structured resource review steps

- A structured review of all the studies done so far in the field of errors with or without resulting harm in the emergency department. The goal of this stage was to find the answer to this question: is there an indicator tool to check for medical error in the ED with or without hazardous effects?
- Persian studies: After developing a search strategy, scientific information database (SID), Iran Medex, Magiran, Islamic World Science Citation Center (ISC), and Google Scholar databases were investigated for the studies published in Farsi. We also searched PubMed and Scopus databases for English language studies conducted in Iran.
- Overseas Studies: To achieve overseas studies, we focused our search strategy on studies conducted only in English, and the PubMed and Scopus databases were investigated separately with the following search strategy and keywords:

"Patient safety system AND Emergency Department or trigger tool AND medical error."

- According to the keywords, 502 articles were found in PubMed, 100 articles in Google Scholar, and 410 articles in the Scopus database. Duplicated articles were removed. Based on the search for article references and similar ones, four articles were added to this number. A total of 1016 article titles were initially reviewed. Two independent researchers performed an article evaluation in two different locations on the same date, and then the results were compared. In case of disagreement between them, the opinion of the third researcher was used. At this stage, 295 articles were selected. Interpreter reliability was high (0.82). Forty-two articles were included in the study for final analysis.

2. Delphi is a structured process for predicting and assisting in decision-making during survey rounds, gathering information, and finally, group consensus with different approaches. A modified Delphi method was used to identify consensus-derived triggers. This approach has been used in previous studies for developing trigger tools. With such a Delphi process and by assuring anonymity of experts' responses, we avoid group influential opinion effects. We used a face-to-face meeting of the panel group discussion and a web-based survey in two different stages.

- In the first stage, panel group participants' characteristics were defined by the study supervisor as below: seven emergency medicine specialists (with at least 2 years of experience working in the emergency department) and two physicians familiar with patient safety concepts with a history of developing trigger tools.
- In the second stage, the aim of the study was described by the supervisor for the participants in the Delphi group work. Then, in face-to-face meetings, we asked them to share their ideas about derived triggers. Furthermore, discuss their advantages or disadvantages. Finally, by analyzing and refining these ideas, eliminating duplicates, and using the same words, the researcher extracted the final list of factors related to the research problem (trigger tool).

3. A final web-based survey was performed to evaluate and refine the triggers. We used a three-point Likert scale for each item. Panel staff were also asked to add or remove items from the checklist or change the risk levels specified in the checklist, along with stating the reason and, if possible, stating the scientific source. Consensus was then used to formulate the trigger tool. At this stage, we aimed to determine the importance of each item to modify our list without losing crucial ones.

4. As the final step, in a field study, we used our developed EDTT in a tertiary hospital emergency department in Mashhad. We evaluated 100 patients' records with this checklist to estimate their utilization.

4.Result

First step: systematic review

In *this* study, a systematic review was performed for electronic resources. In this search, the Persian equivalent of this subject had not been done in our country so far. To achieve overseas studies, we focused our search strategy on studies published in the English language, in the PubMed and Scopus databases, and the first ten pages of Google Scholar separately with the following search strategy:

"Patient safety system AND Emergency Department or trigger tool AND medical error."

All searches were completed in December 2016. According to these keywords, 502 articles were found in PubMed, 100 articles in Google Scholar, and 410 articles in the Scopus database. Duplicated articles were removed. Based on the search for article references, four articles were added to this number. A total of 1016 article titles were initially reviewed. Two different researchers performed electronic resource searches in two different locations on the same date, and then the results were compared. The initial selection of related articles based on the title was done by these two independent researchers. In case of disagreement between them, the opinion of the third researcher was used. At this stage, 295 articles were selected. Interpreter reliability between researchers was high (0.82).

In the second stage, the English abstract of the articles was obtained and reviewed by two independent researchers, and the disputes were resolved by the third person's suggestion (dissertation supervisor). Unrelated items were also removed. In this section, 44 articles were selected for final analysis. Finally, after reviewing the full text, 42 articles were included in the study for final analysis. All studies were cross-sectional studies without intervention. The PRISMA chart of the study is shown in Figure 1. The first article on Trigger Tool was published in 2003 in the United States by Rozich. The last article published in the study period was done by Griffy in 2016 in the United States**.**

Second and third steps: trigger identification and adaptation

Finally, 42 items were extracted from the articles as triggers. Then, in a meeting with emergency medicine experts, the obtained triggers were discussed, and according to their idea, nine substantial and error-related and high-risk situations were added to the list based on the monthly emergency morbidity/mortality sessions results. Also, one case (serum alcohol level of more than 400) was removed from the final checklist in the initial evaluation due to not being performed in all emergency patients**.**

In the first round of Delphi, the members of the expert panel were asked to rate the items of the trigger tool questionnaire and express their agreement with each of the items on the three-part Likert scale. Moreover, we asked them to answer a supplementary open-ended question. Statistical analysis of the responses was performed using the central measurements and the scatter index in SPSS software, and the scores of the items were determined. At this stage, triggers with a 75th percentile and higher were accepted, items with a 25th percentile or less were removed, and items between the 20th to 75th percentiles remained for the second round of Delphi. All triggers obtained were approved with an agreement level of 75% and above, and the second round of Delphi was not performed. Kendall's coordination coefficient was 0.821. Experts were asked to complete the electronic form (Table 1) of the trigger tool based on the three-part Likert scale (low, medium, and high).

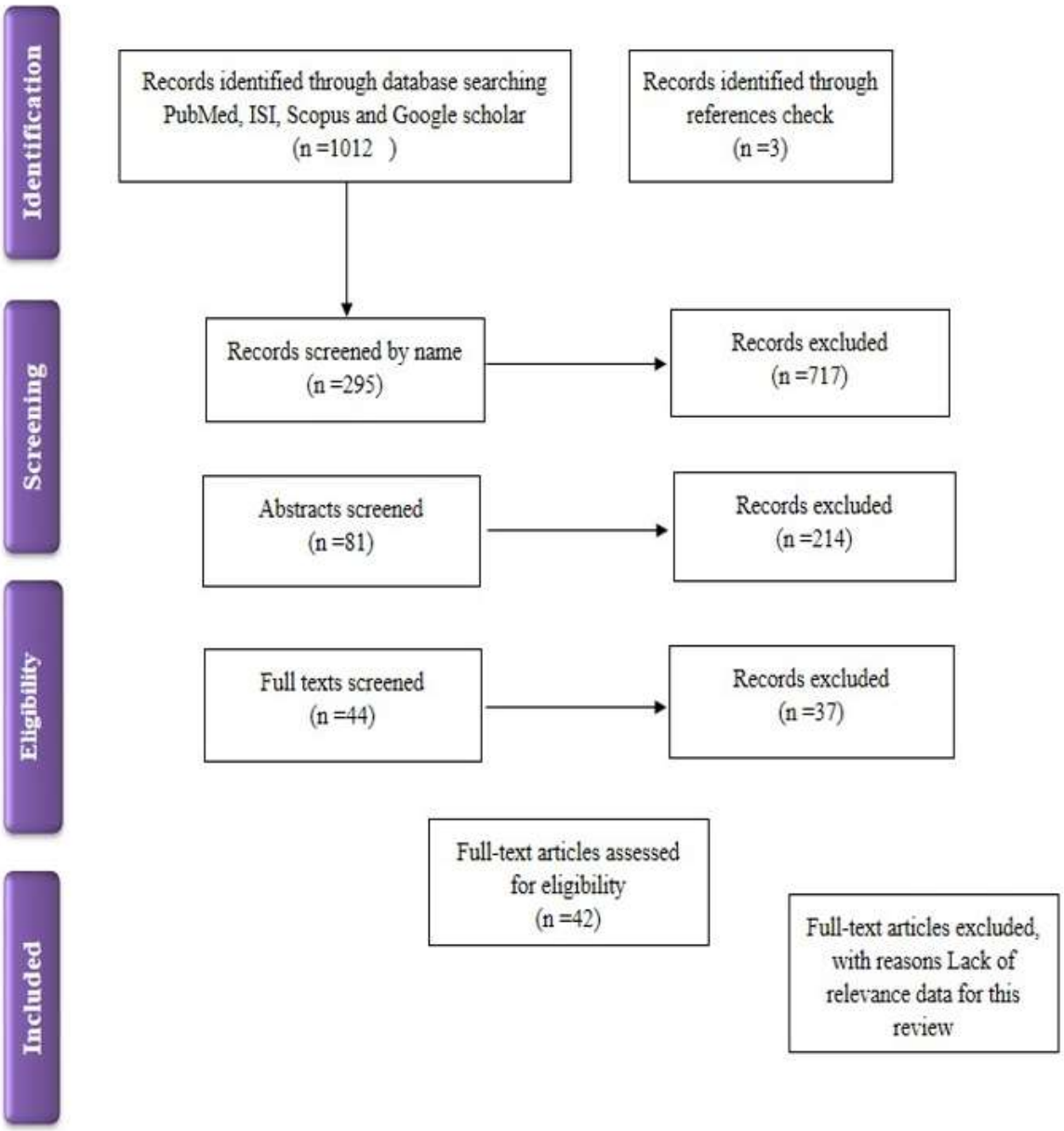

Figure 1. PRISMA Flow Diagram of different phases of performed systematic review

We asked two questions for each item:

1. What is the probability of damage leading to the trigger?

2. In your emergency, is it possible to take preventive action on the result obtained from this trigger?

Table 1. Trigger Ranking

	Do you agree with adding this item to EDTT		What is the probability of damage leading to the trigger?			In your emergency, is it possible to take preventive action on the result obtained from this trigger?		
	Yes	No	Low	Medium	High	Low	Medium	High
Blood sugar < 50 mg/dl								

The second question was to evaluate patient safety approaches and improve health quality. They were also asked to add new items to the original list or change the scales mentioned in the trigger tool and cite the references. For example, change the INR range from 5 to 6.

For the next step, the obtained triggers were divided into six main groups for ease of access. The Kendall coordination coefficient of experts' opinions on the final EDTT for each domain obtained by the Delphi technique is summarized in Table 2.

Table 2. The Kendall coordination coefficient of experts' opinions on the final EDTT

Number of triggers	Group	K
9	Care module triggers	79.3
6	Patient-related module triggers	82.5
7	Medication module triggers	78.9
7	Laboratory module triggers	83.6
7	Procedure module triggers	80.9
14	Situational module triggers	83.4

Table 3. the consensus derived triggers

Care module triggers	***Laboratory module triggers***
C.1: change in triage level	L.1: Lactate > 4.0
C.2:upgrade in care or change of service within 24 hours of admission	L.2: Potassium > 6.0
C.3: code/arrest (CPR) within 24 hours of admission	L.3: INR > 5.0
C.4: patient fall	L.4: Glucose <50 OR more than 350
C.5: more than two consults on a non-trauma patient	L.5:PH<7.1
C.6:A return visit to ED within 72 hours resulting in hospital admission	L.6: Na less than 120 or more than 150
C.7: without disposition after 12 hours of ED stay	L.7: Troponin 3upper limit two times within three or six hours in patients without cardiac compliments
C.8: return visit to ED with the same complaint in a week	**Procedure module triggers**
C.9: ED length of stay > 12 h	PP.1: Procedural sedation
Patient situation module triggers.	PP.2: Central line insertion
P.1: Farsi is not the primary language	PP.3: Chest tube insertion
P.2: Tachycardia (HR > 130)	PP.4: Intubation
P.3:Systolic BP > 90 on ≥2 readings at least 15 min apart	PP.5: Interosseous cannulation
P.4: older than 65 years	PP.6: Nasal intermittent positive pressure ventilation (NIPPV)
P.5: Oxygen saturation < 90% on two readings	PP.7: Radiologic interventions in traumatic patients such as pelvic fracture
P.6: change in level of consciousness	**Situational module triggers**
Medication module triggers	S.1: Deliver in the ED
M.1:Reversal agent (naloxone, flumazenil administration)	S.2: Pregnant patient
M.2: Vasopressor administration	S.3: Homeless patient
M.3:Heparin administration (includes enoxaparin, fondaparinux, and etc)	S.4: Hemodialysis patient
M.4:Opiate and benzodiazepine administered within 1 h of one another	S.5: Diabetic ketoacidosis (DKA) patient
M.5: Hypertonic saline administration	S.6: Aortic Dissection
M.6:Use of benzodiazepines or opioids in patients ≥65 years	S.7: Septic Patient
M.7: Atropine administration	S.8: Mesenteric Ischemia
	S.9: Spinal Injury
	S.10: Pelvic Fracture
	S.11: Depressed Skull Fracture
	S.12: Rib Fracture
	S.13: ST-Elevation myocardial infarction (STEMI)
	S.14: Ischemic Strokes Needs Intravenous Recombinant Tissue-Type Plasminogen Activator (IV r-TPA)

Final step: Review of patients' records with EDTT

At this stage, 100 cases of patients admitted to the emergency department were randomly evaluated with EDTT for one month. If there were no triggers, the case would be excluded. If the trigger was identified, a more detailed search was performed to find the error, percentage of incidence, and the severity of the damage was classified based on the Medication Event Reporting and Prevention (MERP).

The files were reviewed at two levels. First, all 100 selected cases were reviewed separately by two researchers. The supervisor of the study re-examined all the studied cases. The difference in finding the triggers was observed in 5% of the cases. In the second level, a more detailed review of the case was obtained to evaluate if the derived trigger is related to an error or not. The total time of this process, according to the proposal of the Health Institute, was considered to be about twenty minutes. However, due to the relatively shorter presence of patients in the emergency department and the brevity of their case, this time can be reduced by even half.

Out of 100 examined cases, 82 cases (82%) had a trigger, and 18 cases had none. One hundred twenty-four triggers were identified in 82 cases. Of these triggers, 99 (79.8%) were related to a medical error.

5. Discussion

In this study, we designed an emergency department trigger tool (EDTT) using a systematic review and the Delphi method. This tool has 50 triggers in six groups. The first five groups are triggers caused by health system errors, and the sixth group is high-risk conditions that can make patients more vulnerable due to the complexity of their conditions.

The Institute of Health Care aims to reduce medical errors since 1999. However, according to statistics, the number of errors has not decreased. The reason for this can be improvements in methods for evaluating and identifying medical errors (37).

Traditionally, the quality of services and patient safety in the emergency department is assessed by holding monthly meetings to review cases randomly or to review morbidity and mortality. Such a screening method is not accompanied by sufficient evidence to consider factors affecting the quality of service (28, 39).

The Global Trigger Tool was first introduced as an effective way to identify the risks and side effects of health care services in the safety field. Unfortunately, the Global Trigger Tool had only two triggers in the emergency department field (ED stay more than 6 hours and readmission within 48 hours after discharge). Although many studies have been conducted on errors in the emergency department, there is no particular tool for evaluating health care in the emergency department. In 2016, Griffey (28) designed the first emergency trigger tool. His original article did not elaborate on selecting triggers and focused more on marginalization. Also, no similar study has been conducted in our country, and the limited studies conducted are based on voluntary error reports and reviews of morbidity/mortality report session files.

In one study in Iran, the most important causes of medical error were lack of sufficient information, distraction, and compulsion to do several things simultaneously. The most important reasons for not reporting the error were the fear of revealing the mistake and creating legal issues following it, the fear of the wrong effect on the evaluation score, and the occurrence of educational consequences (22). In examining ED, errors leading to complaints to forensic medicine were diagnostic and treatment-related errors (24).

New studies about trigger tools in

different units have shown that the rate of adverse event detection with this tool is between 3 to 10 times higher than the number of voluntarily reported events (34, 37). On the other hand, many reporting cases seem subject to harmless errors, and the trigger is more specific for identifying harm to the patient (29). In our study, 82 cases (82%) had 124 triggers, and 99 (79.8%) were related to a medical error.

In this study, a systematic review and the point of view of emergency medicine experts were used to design the error-detecting tool, which leads to selecting a wide range of triggers in the emergency department. Using their opinions helped us to introduce gray triggers (not mentioned in the references). Such as "emergency department stay longer than 12 hours", which is very important in referral training hospitals like Mashhad due to the high volume of patients in the wards and the emergency room overcrowding.

On the other hand, the group discussion session made it possible for another group of triggers to be defined as "high-risk conditions and critical diagnoses in the emergency room," which was not noticed in traditional versions of trigger tools such as the Global Trigger Tool. For example, homeless patients are neglected due to the situation and are at risk of medical error. The probability of injury and its severity can be higher than other patients. Or patients who are eventually admitted with aortic dissection diagnosis might be neglected due to the initial non-specific complaint. Attempts were made to include all aspects of health care services in the trigger, from the beginning and first patient's visit and history taking and physical examination, possible diagnoses, and medical or surgical interventions, as well as their laboratory results tool.

The sixth category of triggers introduced in this study has this fundamental difference with the global trigger focusing on omission instead of commission. Therefore, therapeutic and diagnostic deficiencies can also be identified by this group. In this study, we asked the experts to determine how much the error caused by the triggers can be preventable. 79% of the triggers were stated to be preventable, but in order to examine this amount accurately, it is necessary to re-examine the files with a focus on the ability to prevent unwanted accidents without blaming the culprit. Many cases were preventable in reviewing emergency cases.

In previous studies and according to the report of the Institute of Health, it is better to use select targeted selection method for choosing medical records. It has been suggested that patients who are hospitalized for more than 3 days could be examined by Trigger Tool. Griffey (28) suggested to evaluate all patients admitted to the emergency room. Some studies have suggested that high-risk patients or people with higher levels of triage or patients based on the disease severity index in the emergency room should be included in the study. Because in this study, we tried to evaluate trigger tool performance, we randomly selected 100 patients regardless of their triage level or high-risk condition.

Using EDTT has the advantage over voluntary reporting methods or root cause analysis, which can examine more cases in less time and estimate the severity of damage in the event of an unintended accident. In our study, diagnostic and medication errors were the most common cases. In Pourali's study, the errors of emergency physicians were mainly due to diagnostic errors (24).

In a Swedish study about the pediatric Trigger Tool, the average number of triggers detected per child was 6 (35). In our study, the number of triggers obtained per 100 cases was 1.2, and in Griffey's study, 1.05 triggers were found (29). However, the percentage obtained in our study may not be accurate due to the impossibility of examining trauma patients.

Previous studies have shown that trigger tools can only identify hazards and errors

from actions recorded in medical files. In other words, if the patient with septic shock is not treated with appropriate antibiotics, an error occurs but cannot be checked with a trigger tool. In the currently designed tool, we tried to include several of these items, which were influential during the Delphi survey and the results of mortality sessions, as the sixth group of triggers. It can be said that one of the most essential advantages of the current trigger tool is compared to previous versions. However, completing these cases requires more cases to be reviewed.

Some of our study's limitations are listed below:

Considering the use of the consensus method, experts' opinions about evaluating and selecting the obtained triggers may have been their personal opinion in assessing the extent of injury and the possibility of injury prevention in the emergency. To reduce this error, we tried to use the opinions of two patient safety experts and emergency medicine experts.

Another limitation of this study was the use of the opinions of emergency medicine experts in three academic centers in one province, which can affect the selection of applicable triggers in all city hospitals. To reduce this error, in the face-to-face meeting of trigger selection, it was tried to select items that can be easily implemented in all different emergencies, such as selecting laboratory triggers.

Triggers related to children and patients with poisoning were not considered in this tool. It is suggested to consider appropriate tools for children in future research

6. Conclusion

In this study, we designed an emergency department trigger tool (EDTT) using a systematic review and the Delphi method. The trigger tool obtained from this study can be used to assess high-risk situations and possible cases of emergency medical errors. One of the essential advantages of this tool compared to previous versions is considering high-risk conditions and not performing the correct action as a trigger and danger indicator.

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Availability of data and materials: The dataset analyzed during the current study is available upon reasonable request from the corresponding author.

Conflicts of interest: The authors have no relevant conflict interests to declare.

Consent for publication: All authors agree to publish the article in the present form.

Ethics approval and consent to participate: The study was approved by ethical committee of Mashhad University of medical sciences, Mashhad, Iran. The study was conducted in accordance with the principles of the Helsinki Declaration.

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Author contributions: The study designed, conceptualized and registered by Pishbin E. Rahmani Sh, Review of records, data collection and interpretation were performed by Pishbin E., Rahmani Sh and Panahi M; Interpretation and data analysis was done by Pishbin E and Rahmani Sh. The manuscript was wrote by Rahmani Sh and all authors reviewed and approved it.

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