

Designing and Conducting Initial Application of a Performance Assessment Model for in-Hospital Trauma Care

Yalda Mousazadeh

Department of Health Policy and Management, Iranian Center of Excellence in Health Management, School of Management and Medical Informatics, Tabriz University of Medical Sciences, Tabriz

Homayoun Sadeghi-Bazargani

Road Traffic Injury Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

Ali Janati (✉ janati1382@gmail.com)

Iranian Center of Excellence in Health Management, School of Management and Medical Informatics, Tabriz University of Medical Sciences, Tabriz

Mahboub Pouraghaei

Emergency Medicine Research Team, School of Medicine, Tabriz University of Medical Sciences, Tabriz

Farzad Rahmani

Road Traffic Injury Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

Mobin Sokhanvar

Department of Health Policy and Management, Iranian Center of Excellence in Health Management, School of Management and Medical Informatics, Tabriz University of Medical Sciences, Tabriz

Research Article

Keywords: Performance Assessment, Hospital, Traffic Injury, Trauma Care, Trauma center

Posted Date: May 26th, 2021

DOI: <https://doi.org/10.21203/rs.3.rs-537470/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published at BMC Health Services Research on March 1st, 2022. See the published version at <https://doi.org/10.1186/s12913-022-07578-2>.

Abstract

Background: Trauma is a major cause of death worldwide, especially in developing countries. The increasing cost of health care and the differences in the quality of provided services indicates the need to assess trauma care. This study aimed to develop and use a performance assessment model for in-hospital trauma care with a focus on traffic injuries.

Methods: This multi-method study was conducted in three main phases of indicators determination, model development, and model application. Trauma care performance indicators were extracted through literature review and were confirmed using a two-round Delphi survey and experts' perspective. Two focus group discussions and 16 semi-structured interviews were held to design the initial model. In the next step, components and final form of the model were confirmed following pre-determined factors including importance and necessity, simplicity, clarity, and relevance. Finally, the model was tested by applying it in a trauma center.

Results: A total of 50 trauma care indicators were approved after reviewing the literature and obtaining the experts' views. The final model consisted of six components of assessment level, teams, methods, scheduling, frequency, and data source. The model application revealed problems of a selected trauma center in terms of information recording, patient deposition, some clinical services, waiting time for depositing, recording of medical errors and complications, patient follow-up, and patient satisfaction.

Conclusion: Performance assessment with an appropriate model can identify deficiencies and failures of provided services in trauma centers. Understanding the current situation is one of the main requirements for designing any quality improvement programs.

Background

Trauma is one of the major causes of mortality in the world, which mostly occurs in the first four decades of life (1). It is reported that every year nearly 5.8 million people die as a result of trauma (2). Plus, trauma occurs in all countries and is a common problem for modern societies (3). On the other hand, a significant share of the burden of diseases results from trauma (2, 4). Also, trauma annually leads to more than 50 million Disability-Adjusted Life Years (DALY) (5). The other point is that traumatic injuries can cause higher mortality rates compared to Acquired Immune Deficiency Syndrome (AIDS), Malaria, and Tuberculosis (6). Therefore, trauma is a critical and time-dependent health issue that requires an instant healthcare intervention to reduce the probability of mortality and disability (7).

Out of various types of trauma, trauma caused by traffic accidents is a life-threatening condition for all age groups (8). It is reported that traffic injuries have risen from 999,000 in 1990 to more than one million deaths in 2002, and it was predicted to reach about two million deaths in 2020 (9). Evidence shows that the trauma resulting from traffic accidents leads to the death of 21 million people and the disability of 20–50 million people, annually, most of whom are young (10, 11). In Iran, traffic injuries are the second leading cause of death, accounting for 40% of unusual deaths (12, 13). It is undeniable that the injuries

caused by trauma are more serious in developing countries due to the lack of an organized trauma system and the extent of occasions leading to trauma, for example, traffic accidents (14).

As to trauma care, health organizations are responsible for providing cost-effective, patient-oriented, and safe health services at the right time and place to trauma patients (3). The key feature of good trauma care is the quick transportation to the facility where appropriate trauma care is available and definitive treatment can be delivered within the first hour of the injury (15). Prevention activities, communication infrastructure, medical direction, trained workforce, pre-hospital care, transportation services, triage, in-hospital care, rehabilitation, public education, and evaluation of trauma capacity are the major components of the trauma care system (15). Reports indicate that people do not receive the same services for accident injuries even in a similar environment, and also evidence suggests that quality services are not always available for them (3). Therefore, the quality of care provided to traumatic patients needs to be assessed and improved (16, 17). Furthermore, the high and rising costs of health services also confirm this need (18).

The Trauma Committee of American Surgeons College was one of the first organizations, which developed indicators to trauma care assessment in the form of a quality improvement program (19). However, many of the developing countries do not have an accreditation process, standards, and specific assessment tools for trauma centers (20). On the other hand, related indicators are observed in developed countries for a long time, but their application is limited in low and middle-income countries due to resources shortage (21). In addition, it is recommended the use of context-related audit filters in the area of health services provision (5). Nevertheless, the Iranian Ministry of Health and Medical Education (MOHME) defined just five general criteria as hospital emergency performance indicators, which are not specifically related to trauma services. Hence, the present study was carried out to design and conduct the initial application of a model for trauma care assessment with a specific focus on traffic injuries.

Methods

This multi-method study was conducted between 22 June 2018 and 22 October 2019 over three main phases of indicators determination, model development, and model application in the hospital.

Determining indicators

A comprehensive literature review was conducted by searching five electronic databases including PubMed, Ovid Medline, Science Direct, ProQuest, and Scopus, and also Google Scholar search engine. In addition, Persian databases including Scientific Information Database (SID) and Magiran were searched. In the next step, the indicators regarding the assessment of in-hospital trauma services were extracted from related articles. Then, the extracted indicators were evaluated by a panel of five experts regarding feasibility, importance, relevance to the health system, and compliance with Iranian hospitals context. Finally, the selected indicators were categorized according to content and examined in terms of content validity through a two-round Delphi survey. Participants (n = 30) consisted of 17 medical doctors and

specialists (general practitioner, emergency medicine, anesthesiologist, orthopedics, internists, and neurologist), 4 nurses, and 9 faculty members of health policy, health in disasters and emergencies, and healthcare management. All the participants had work or research experience in trauma care.

In the first round of the Delphi survey, the questionnaires were distributed after providing enough explanations and the deadline was determined to be two weeks for filling them out. In this round, the indicators were examined based on the four criteria of necessity, relevance, clarity, and simplicity. Accordingly, the Content Validity Index (CVI), Content Validity Ratio (CVR), and the modified kappa were calculated (22, 23). In the second round, the indicators were presented based on the scores of CVI, CVR, and the modified kappa. Finally, the indicators approved in the second round were listed and categorized.

Model development

Two Focus Group Discussions (FGD) were held (a total of 12 people in two sessions) and 16 semi-structured interviews were performed to identify how to assess trauma care using extracted indicators. Each FGD and interview lasted 60 to 90 and 45 to 60 minutes, respectively. The participants were selected based on purposive sampling (24). After obtaining informed consent, the participants' statements were electronically recorded and then transcribed verbatim. The content analysis method (25) was used to analyze the text of interviews and FGDs. Eighty percent of the participants in this phase were from the previous stage (Delphi and Panel). According to the results of FGDs and interviews, the initial form of the model and its components were developed.

To conduct model approval, a three-part questionnaire was designed and provided to 10 selected experts in a separate session. The majority of these people were faculty members and also worked in trauma centers. The first part consisted of socio-demographic variables of ten participants (Table 1). In the second part, the experts' views were asked regarding the main and sub-components of the model according to the criteria of importance and necessity, simplicity, clarity, and relevance, based on a 9-point Likert scale. The components with scores between 7 to 9 were approved and the components with scores of 1 to 3 were removed. It was also discussed to agree on components with a score of 4 to 6 (26). The third part of the questionnaire included questions for validation and agreement on the final form of the model. Accordingly, 12 areas were examined. These 12 areas included model feasibility, compatibility with upstream documents, acceptance of the proposed model by stakeholders, efficiency, flexibility, model sequence, model fit, the balance between model components, and a general question. Based on these 12 items, a form was designed based on the 4-point Likert scale (1: low, 2: very low, 3: high, 4: very high) and the experts expressed their opinions. Then, item-level Content Validity Index (I-CVI) and KAPPA were obtained (27).

Model application

The initial model application was conducted to assess in-hospital trauma care in a trauma center in the metropolitan city of Tabriz in the East Azerbaijan Province. Units involved in providing the required data for general indicators included the medical record department, emergency medicine department, quality

improvement office, patient safety office, nursing office, and trauma ward. It should be noted that information on general indicators was collected for one year.

In order to collect data about the specific indicators, 200 patients were selected that referred to a referral trauma center for three months in the emergency department. A checklist consisting of 27 questions was designed based on the consensus of the research team and two emergency medicine specialists. Four other experts commented on the checklist and thus its validity was confirmed. Cronbach's alpha coefficient was calculated for four dimensions of the checklist by 0.7, 0.65, 0.73, and 0.71, respectively. The checklist consisted of patient information, accident mechanism, patient triage level, vital signs, Glasgow Coma Scale (GCS), some procedures performed for the patient including (intubating, setting chest tube, fracture fixation, bleeding control, and blood and fluids transfusion), diagnostic procedures and related waiting time, patient satisfaction, and the final decision in the emergency department.

The data were collected using observation of the patient and the measures taken to provide services, and interviewing patients and their accompanies, asking staff, and reviewing the patient's document. The gathered data were analyzed using Stata (Stata 14 package software statistical) software. Then, the data were reported using descriptive statistics. One-Sample Kolmogorov-Smirnov Test was applied to test the normality of the distributions of the variables. Accordingly, Kruskal-Wallis, Chi-square, One Way ANOVA, and linear regression tests were also used to examine the relationship between variables. Figure 1 gives an overview of the study procedures.

Results

Determining indicators

In a comprehensive literature review, 140 indicators were found to be associated with in-hospital trauma care after reviewing 51 articles, 3 guidelines, and 2 books. Then, some indicators were excluded or merged due to insignificance, differences in the management system of countries, lack of sufficient data (physical and electronic), time, human and physical resources shortage. Therefore, in the Delphi survey, 57 indicators were entered and investigated. In the first phase, CVR, CVI, and Modified Kappa were calculated to be 0.64, 0.85, 0.83, respectively. A total of 50 indicators were confirmed in the second phase of Delphi. Figure 2 gives an overview of this step of the study. Also, the classification indicators for assessing in-hospital trauma care are shown in Fig. 3.

Model development

Prerequisites and assessment steps were determined based on the experts' opinions. Accordingly, assessment prerequisites included a component leader, having the support of service providers, determining the level of facilities and the nature of activities, and also a person to collect data. The specialists insisted on investigating indicators all the time and being updated if necessary. It was because the indicators should be evidence-based and in connection with outcomes. Determining the assessment period (daily, weekly, monthly or annual) was referred to as another necessity. The experts

believed that assessment should have broad dimensions and different aspects including assessment of awareness, knowledge, attitude, and skill of service providers, and patient satisfaction. The experts asserted that both external assessments by auditor organizations and internal assessment by process owners should be considered. Finally, the experts suggested that the assessment results investigate within hospital committees and by relevant authorities. Then be made public. Figure 4 gives an overview of the FGDs and interviews findings.

Based on experts' view, the initial form of the performance assessment model was designed in six components by the research team. These components were:

1. Selection of the assessment level (including hospital wards, and patient/ staff views)
2. Assessment team (specialized and non-specialized)
3. Measurement method (assessment content based on the Donabedian framework- Measuring tool)
4. Scheduling (based on plan or case)
5. Frequency of assessment (general and specific)
6. Data source (current reports, periodic reports, and case reports)

All model components in the Delphi survey earned a median of 7 to 9 and therefore were approved. The experts reached a consensus on all the components and also the general shape of the proposed model. The self-assessment team was added to the assessment teams based on their comments. Also, the score of k and I-CV was obtained as 1 except for two areas of the model including acceptability by stakeholders and the simplicity of the model in other areas under study. The final form of the model is presented in Fig. 5.

Model application

A total of 5163 road traffic patients were transported by ambulance in 1 year. The number of patients admitted to the emergency department was 330–340 patients per day. A total of 1951 road traffic patients were hospitalized, which was 0.04% of the total hospitalized patients. A trauma registry related to traffic accidents was set up in the trauma center. The in-hospital trauma team consisted of emergency medicine specialists and senior residents in surgery, internal medicine, orthopedics, and neurologists. There was no tonometer for proper treatment of compartment syndrome. Eleven Root Cause Analyses (RCA) were performed during one year, none of which was for road traffic patients. Information related to Failure Modes and Effects Analysis (FMEA) was not recorded. The level of satisfaction of trauma patients referred to the emergency department was not assessed during a year. The patient's functional status was not assessed after discharge and there was no protocol for referral to rehabilitation centers. Table 2 shows the results of other general indicators.

In this part of the study, 200 road traffic patients referred to the hospital emergency department were examined. The mean and Standard Deviation (SD) of patients' age was 33.13 and 19.04, respectively. 42% of patients were sent to the hospital from different cities of East Azerbaijan province and 58% from Tabriz city. The mean (SD) of GCS in 170 patients was 14.41 (2.36). Out of 200 patients, imaging

services were performed for 186 patients (93.47%). Table 3 shows some demographic characteristics and hospital information of the patients. Waiting time of Para clinical procedures and patient outcomes in the emergency department are presented in Table 4.

The Chi-square test showed a statistically significant relationship between outcome and mechanism of injury, location of injury, and GCS group ($p < 0.05$). Based on Kruskal–Wallis test, the relationship between GCS score and the outcome was statistically significant ($p < 0.05$). There was a statistically significant relationship between triage level and outcome ($p < 0.05$). The waiting time to receive a CT scan increased the waiting time for discharge by 1.46 times ($p < 0.05$). Also, the waiting time for receiving CXR increased the waiting time for discharge by 1.56 times ($p < 0.05$).

Out of 200 patients, two patients were not triaged, or their triage was not recorded. In addition, five patients were re-triaged due to lower triage than the patients' injury level. The neuromuscular status of 12 patients was not checked. For eight patients in the operating room, there was no vacancy for treatment at the time of the medicines order. Due to the failure of the Picture Archive and Communication System (PACS), the decision was made with delay in five patients. There was a delay in depositing five patients due to receiving counseling. The hospitalization of five patients was delayed due to a lack of empty beds. The quality of some of the procedures performed for patients is presented in Table 5.

Discussion

This study was one of the few studies in Iran exploring specific indicators of trauma care. In addition, it provided a model for assessing hospital performance in trauma patients' management. Many important measures for assessment including the assessment level, assessment team, method, scheduling, frequency, and using assessment results are specified in this model. Also, model application in a trauma center showed the problems as to information recording, patient satisfaction, some improper clinical services, inadequate follow up and rehabilitation services, waiting time for depositing, and documentation and audit of errors, complications and deaths.

In the present study, 50 indicators related to trauma care were identified and presented to be applicable in the Iranian hospital context. The indicators compare the actual trauma care against the ideal standard and it reveals patients who need more care and receives less care (28). Indicators provide the means to correct errors and improve performance in the future (18). According to a study conducted at Kaen Khon Hospital before and after the implementation of a set of audit filters and identification of weakness, preventable mortality was reduced from 2.7 to 2% (29). It has been mentioned that some indicators were identified to be appropriate for the conditions of the countries. In the study of Santana et al. after reviewing the literature and four Delphi rounds, 98 indicators were identified and used to evaluate trauma centers in the United States, Australia, Canada, and New Zealand. The owner of the selection of these indicators purposefully intended to improve quality, ease of interpretation as well as implementation (28).

In this study, indicators of trauma care were identified based on studies, but some specialists just approved indicators that are appropriate to the situation of Iranian hospitals. Studies have shown that if

the context-related audit filters are used more successfully. A study of Asian countries found that trauma-related indicators were not used. The reasons for the lack of indicators included the lack of standard data collection mechanisms, limited resources (for example, lack of adequate human resources, and inadequate interaction with local health care). In addition, it is emphasized that simpler and more relevant indicators should be used (5). In another study, it is emphasized that in compiling special indicators, the cases should be used whose information is in the form of a registry (30).

In this study, the trauma care assessment model including six components was designed based on the views of experts and taking into account the context of the study. Based on some studies, many developing countries lack an accreditation process for trauma centers. Similarly, studies emphasize that it is better to have indicators and filters related to the context (5, 20). Moeini et al. used the survival probability assessment system and concluded that despite the differences between developing and developed countries, survival probability models designed in developed countries such as the United States can be used after localization and development of coefficients and variables derived from regional databases (31).

One of the most important points in the model presented in the study was the perspective of the service recipients as a level of assessment. This point is usually less used in assessments. The present study also showed that patient satisfaction was not assessed during one year. Murray points out that the issue of quality from the perspective of service recipients has been raised in various health programs to continue to use care, ensure effectiveness, and engage people and other stakeholders in health care (32). Santana et al. presented that an assessment should be comprehensive and patient-centered. Patient-centeredness includes examining the views of patients as recipients of service, which is justified through satisfaction (33). Another important point in the model designed in this study was to consider the indicators of structure, process, and other outcome indicators in addition to mortality and disability. Considering the framework, for example, Donabedian framework expands the indicators causes that cover all aspects of care (28).

Mortality is considered a key indicator in assessing trauma care (19). In the present study, it was included as an important indicator in the model. Also, the mortality rate of road traffic patients was about 9% during one year. In Iran, the prevalence of traffic accidents is twenty times higher than the global average, and disability due to traffic accidents has doubled in European countries (34). According to the World Road Safety Report, the death rate due to traffic accidents in Iran is 32.1 per 100,000 people (35). Disability was also included in the study model due to less attention as the main indicator. Unfortunately, the evaluation revealed that the evaluation of the patient's functional status is not performed after discharge in the trauma center under study. According to studies, patients rarely have a definite and stable state of health at the time of discharge (36–38). Therefore, measuring functional status and quality of life is very important and helps health professionals to better evaluate the effectiveness and effectiveness of interventions (39, 40).

Many quality improvement measures, including the audit of death and the comprehensive recording of errors and complications, RCA and FMEA had a poor condition at the trauma center under study. In a review of the studies, Katherine et al. concluded that improvement in trauma care has been reported in most studies following recovery programs. In only 2 of the 36 studies found, no effect was reported. Also, no studies reported adverse effects (41). It seems that suitable efforts to improve quality and support patient safety can improve patient-based outcomes and reduce costs(42).

The assessment results showed that the most injured were pedestrians. In line with the present study, the classification of the patients injured in road traffic accidents in Iran showed that pedestrians with 39.8% were the most injured (43). The head was the most frequently injured part of the body in this study. Based on the study by Ghafari Fam et al. on pedestrians referred to Shohada Hospital, Tabriz, the most frequent area of injury was lower limbs with 43.5% (43) unlike the present study. According to Taghipour et al., anatomy of the individuals injured in driving accidents showed that head injury with a frequency of 220 and face injuries with the frequency of 169 cases were the most damaged organs (44), which is consistent with the findings of the present study.

According to the information recorded in the assessment, the length of stay in the emergency department was very long. Minutes and even seconds are important for emergency department patients because 75–85% of deaths occur in the first 20 minutes after an accident and most events occur in the first 80 minutes, when important decisions are made, progressed, or controlled (45). According to the accrued statistics, the readmission rate was reported 16.64% without mentioning the reason in this study. The growing demand for health services, limited resources, and staggering costs due to improper use of hospital facilities, has caused many problems in hospitals. Therefore, the management of hospitals and health officials of the country should pay more attention to the optimal use of hospital beds and clinical efficacy and cost-effectiveness (46).

In the studied hospital, only two cases of complications including postoperative infection and postoperative bleeding were studied. Also, surgical site infection occurred in six patients. Studies have shown that surgical site infections, with an incidence of 2 to 5%, account for 24% of nosocomial infections and increase morbidity and mortality (47). On the other hand, there is a need for a more comprehensive review of all complications. Of course, in this regard, collecting statistics is not helpful and it is necessary to identify and eliminate the cause of such cases to reduce the inconvenience of patients and reduce costs.

Error reporting in this study was not comprehensive and most of the reported errors were related to nurses. Most errors included bedsores, registration errors, and medication errors. In most similar studies, nurse errors were recorded. In the study of Bozorgzad and Hemmat, which focused on nursing errors, 44% of errors occurred due to lack of timely notification to the physician orders, and 96% related to problems in recording nursing reports (48). Jolaei et al. stated that the average medication error of nurses during the three months was 83.5 cases and the average error report was 8.9 cases. The occurrence of

medication errors in the mentioned study was significantly associated with the working conditions of nurses (49).

In the present study, the documentation situation was not at the desired level. Rangraz and Mousavi reported the highest percentage of completion of emergency files to be 77% and the lowest 45% and observed that in none of the studied units, the important elements of emergency documents were not completed to the desired level (50). Given the importance of the patient's case in subsequent follow-ups and the preparation of statistics for decision-making, this issue needs to be investigated.

In this study, we found the waiting time to receive some services affected deposition and patient satisfaction. Similar to the present study, the results of various studies showed that patient waiting time is one of the influential factors on patient satisfaction. In a study on the views of physicians working in the emergency department on the causes of clients' dissatisfaction, 61% of them stated waiting time and 83% lack of adequate communication with the patient as the main reasons for this dissatisfaction (51). Based on another study, waiting time to receive various services in the emergency department affects the final deposition. The waiting time for receiving emergency services in patients who need laboratory and imaging services and in patients transferred to the hospital via 115 was significantly longer than in other patients (52).

In this study, deficiencies were found in some specific equipment. Lack of resources and facilities for trauma care is evident in many developing countries. Mook et al. examined minimum trauma care facilities in four countries: Mexico, Vietnam, Ghana, and India. Surveys were conducted at 800 rural and urban sites. The equipment in these countries was relatively sufficient. However, there were defects, especially about the lack of airway equipment, chest tubes, medications, and the long waiting time for equipment such as radiography and laparotomy in rural hospitals (53).

Limitations And Strength

This study is one of the few studies on trauma care assessment in Iran. In this study, the views of experts working in the field of trauma care were collected. Another strength of this article was the consideration of the scientific evidence for trauma care indicators. The findings of this study were a first step in improving the quality of trauma care. However, this study also had weaknesses. One of these weaknesses was the omission of some indicators due to the impossibility of collecting data. Another limitation was the collection of data from only one trauma center. To validate the results of this study should be checked in more centers.

Conclusion

In this study, the indicators as well as, the steps required to assess the performance of trauma care were designed based on a literature review and opinions of experts and presented in the form of a model. The use of the model leads to a systematic assessment and comprehensive review of performance. Model

application revealed some problems as to the information, errors, and complications recording, patient satisfaction, some improper clinical services, follow-up and rehabilitation services, and waiting time for depositing. Identifying performance deficiencies leads to appropriate planning and intervention. So, it will reduce the number of victims and improve outcomes for families, the community, and the health system.

Abbreviations

DALY: Disability-Adjusted Life Years; AIDS: Acquired Immune Deficiency Syndrome; MOHME: Ministry of Health and Medical Education; CVI: Content Validity Index; CVR: Content Validity Ratio; FGD: Focus Group Discussions; I-CVI: level Content Validity Index; GCS: *Glasgow Coma Scale*; RCA: Root Cause Analyses; FMEA: Failure Modes and Effects Analysis; SD: Standard Deviation; PACS: Picture Archive and Communication System; PhD: Doctor of Philosophy; MD: Medicine Doctor ; ATLS: the Advanced Trauma Life Support course; ATCN: the Advanced Trauma Care for Nurses course; ICD: International Classification of Diseases; CPR: Cardiopulmonary Resuscitation; ICU: Intensive Care Unit; T: Temperature; SO₂: Saturation of Oxygen; PR: Prothrombin Ratio; RR: Respiratory Rate; BP: Blood Pressure; GCS: Glasgow Coma Scale; DPL: Diagnostic peritoneal lavage; CT: Computerized tomography; CXR: Chest X-ray; FAST: Focused Assessment with Sonography for Trauma; ECG: Electrocardiogram; SID: Scientific information Database; WHO: World Health Organization

Declarations

Ethics approval and consent to participate

This study is part of a Ph.D. thesis in health services management. The main protocol of this study was reviewed and approved by the Ethics Committee of Tabriz University of Medical Sciences [IR.TBZMED.REC.1396.560]. All methods were carried out in accordance with relevant guidelines and regulations. The informed consent was obtained from all the participants before participating in the study.

Availability of data and materials

The datasets used and analyzed during the current study are available from the corresponding author.

Competing interests

None.

Funding

This research study was supported by Tabriz University of Medical Sciences ((grant number: 58043).

Authors' contributions

Study design: AJ, HS, YM, and MP; Data collection: YM, FR, MP and MS; Data analyzing: HS, AJ, and YM; Manuscript writing: all authors have read and approved the final manuscript.

Acknowledgment

Authors thank the Research Deputy of Tabriz University of Medical Sciences for their financial support and the East Azarbaijan Medical Emergency and Accident Management Center, the Road Traffic Injury Prevention Research Center of Tabriz University of Medical Sciences, and Miss. Aysan Mohammad Namdar for technical cooperation. Special thanks are extended to all the experts to express their valuable views.

References

1. Moore L, Lavoie A, Sirois M-J, Swaine B, Murat V, Le Sage N, et al. Evaluating trauma center structural performance: the experience of a Canadian provincial trauma system. *J Emerg Trauma Shock*. 2013;6(1):3-10.
2. Alharbi RJ, Lewis V, Mosley I, Miller C. Current trauma care system in Saudi Arabia: a scoping literature review. *Accid Anal Prev*. 2020; 144:105653.
3. Mousazadeh Y, Sadeghi-Bazargani H, Janati A, Pouraghaei M. Developing Performance Indicators for Trauma Care: A Four-Stage Qualitative Study. *Trauma Mon*. 2020;25(1):34-51.
4. Glen J, Constanti M, Brohi K. Assessment and initial management of major trauma: summary of NICE guidance. *Bmj*. 2016; 353:i3051
5. Stewart BT, Gyedu A, Quansah R, Addo WL, Afoko A, Agbenorku P, et al. District-level hospital trauma care audit filters: Delphi technique for defining context-appropriate indicators for quality improvement initiative evaluation in developing countries. *Injury*. 2016;47(1):211-9.
6. Lashoher A, Schneider EB, Juillard C, Stevens K, Colantuoni E, Berry WR, et al. Implementation of the World Health Organization trauma care checklist program in 11 centers across multiple economic strata: effect on care process measures. *World J Surg*. 2017;41(4):954-62.
7. Nirula R, Maier R, Moore E, Sperry J, Gentilello L. Scoop and run to the trauma center or stay and play at the local hospital: Hospital transfer's effect on mortality. *J Trauma* 2010;69:595-9
8. Davtalab Esmaeili E, Sadeghi-Bazargani H, Shams Vahdati S, Shokouhi G, Safaiyan A, Salari Lak S. Assessment of survival and hospital care quality in patients with traffic injury in east Azerbaijan. *Trauma Mon*. 2017;22(5): e35303
9. Nantulya VM, Reich MR. The neglected epidemic: road traffic injuries in developing countries. *Bmj*. 2002;324(7346):1139-41.

10. Ziyab AH, Akhtar S. Incidence and trend of road traffic injuries and related deaths in Kuwait: 2000–2009. *Injury*. 2012;43(12):2018-22.
11. Saladié Ò, Bustamante E, Gutiérrez A. COVID-19 lockdown and reduction of traffic accidents in Tarragona province, Spain. *TRIP*. 2020;8:100218.
12. Rasouli MR, Nouri M, Zarei M-R, Saadat S, Rahimi-Movaghar V. Comparison of road traffic fatalities and injuries in Iran with other countries. *Chin J Traumatol (English Edition)*. 2008;11(3):131-4.
13. Moafian G, Aghabeigi MR, Hoseinzadeh A, Lankarani KB, Sarikhani Y, Heydari ST. An epidemiologic survey of road traffic accidents in Iran: analysis of driver-related factors. *Chin J Traumatol*. 2013;16(3):140-4.
14. Mousazadeh Y, Sadeghi-Bazargani H, Janati A, Pouraghaei M, Rahmani F. Prediction of mortality risk in patients with traffic injury: A case study in tabriz hospitals, Iran. *Arch Trauma Res*. 2019;8(2):104-9.
15. Rasmussen TE. A national trauma care system: From call to action. *J Trauma Acute Care Surg*. 2016;81(5):813-5.
16. Stelfox HT, Straus SE, Nathens A, Bobranska-Artiuch B. Evidence for quality indicators to evaluate adult trauma care: a systematic review. *Crit Care Med*. 2011;39(4):846-59.
17. Stelfox HT, Bobranska-Artiuch B, Nathens A, Straus SE. Quality indicators for evaluating trauma care: a scoping review. *Arch Surg*. 2010;145(3):286-95.
18. Moore L, Lavoie A, Sirois M-J, Amini R, Belcaïd A, Sampalis JS. Evaluating trauma center process performance in an integrated trauma system with registry data. *J Emerg Trauma Shock*. 2013;6(2):95-105.
19. Willis CD, Gabbe BJ, Cameron PA. Measuring quality in trauma care. *Injury*. 2007;38(5):527-37.
20. Latifi R, Ziemba M, Leppäniemi A, Dasho E, Dogjani A, Shatri Z, et al. Trauma system evaluation in developing countries: applicability of American College of Surgeons/Committee on Trauma (ACS/COT) basic criteria. *World J Surg*. 2014;38(8):1898-904.
21. Mousazadeh Y. Developing a Hospital Performance Assessment Model for Patients Management with Trraffic Injures: Tabriz University of Medical Sciences, School of Management and Medical ; 2019.
22. E H, M A. *Statistical methods and analyses in health and biosciences a research methodological approach*. 3rd ed. Tehran: Jahade Daneshgahi Publications; 2011.
23. Polit DF, Beck CT, Owen SV. Is the CVI an acceptable indicator of content validity? Appraisal and recommendations. *Res Nurs Health*. 2007;30(4):459-67.
24. Tongco MDC. Purposive sampling as a tool for informant selection. *Ethnobot Res Appl*. 2007;5:147-58.
25. Hsieh H-F, Shannon SE. Three approaches to qualitative content analysis. *Qual Health Res*. 2005;15(9):1277-88.
26. De Villiers MR, De Villiers PJ, Kent AP. The Delphi technique in health sciences education research. *Med Teach*. 2005;27(7):639-43.

27. Hasanpoor E. Developing a Model of Evidence-Based Management for Iranian Hospitals: Tabriz University of Medical Sciences, School of Management and Medical ; 2018.
28. Santana MJ, Stelfox HT. Development and evaluation of evidence-informed quality indicators for adult injury care. *Ann Surg.* 2014;259(1):186-92.
29. Chadbunchachai W, Sriwiwat S, Kulleab S, Saranrittichai S, Chumsri J, Jaikwang P. The comparative study for quality of trauma treatment before and after the revision of trauma audit filter, Khon Kaen hospital 1998. *J Med Assoc Thai.* 2001;84(6):782-90.
30. Newgard CD, Fildes JJ, Wu L, Hemmila MR, Burd RS, Neal M, et al. Methodology and analytic rationale for the american college of surgeons trauma quality improvement program. *J Am Coll Surg.* 2013;216(1):147-57.
31. Moini M, Rezaishiraz H, Zarineh A, Rasouli MR. Evaluation of quality of trauma care in a local hospital using a customization of ASCOT. *Euro J trauma emerg surg.* 2009;35(1):56-60.
32. Murray SA. Experiences with "rapid appraisal" in primary care: involving the public in assessing health needs, orientating staff, and educating medical students. *Bmj.* 1999;318(7181):440-4.
33. Santana MJ, Stelfox HT. Quality indicators used by trauma centers for performance measurement. *J Trauma Acute Care Surg.* 2012;72(5):1298-303.
34. Yadollahi M, Gholamzadeh S. Five-year forecasting deaths caused by traffic accidents in Fars province of Iran. *BEAT.* 2019;7(4):373.
35. Organization WH. Global status report on road safety 2015: World Health Organization; 2015.
36. Holbrook TL, Anderson JP, Sieber WJ, Browner D, Hoyt DB. Outcome after major trauma: discharge and 6-month follow-up results from the Trauma Recovery Project. *J Trauma Acute Care Surg.* 1998;45(2):315-24.
37. Holbrook TL, Anderson JP, Sieber WJ, Browner D, Hoyt DB. Outcome after major trauma: 12-month and 18-month follow-up results from the Trauma Recovery Project. *J Trauma Acute Care Surg.* 1999;46(5):765-73.
38. Currens JAB, Coats TJ. The timing of disability measurements following injury. *Injury.* 2000;31(2):93-8.
39. Marshall JC. Organ dysfunction as an outcome measure in clinical trials. *Euro J Surg.* 1999;165(Supplement_9):62-7.
40. Troidl H. Quality of life: a relevant final criterium in surgery. *Der Chirurg.* 1989;60(7):445-9.
41. Juillard CJ, Mock C, Goosen J, Joshipura M, Civil I. Establishing the evidence base for trauma quality improvement: a collaborative WHO-IATSIC review. *World J Surg.* 2009;33(5):1075-86.
42. Bohnen JD, Anderson GA, Kaafarani HM. Quality and patient safety indicators in trauma and emergency surgery: National and global considerations. *Curr Trauma Rep.* 2018;4(1):9-24.
43. Ghafari Fam S, Sadeghi Bazargani H, Salarilak S. A survey on epidemiological and demographic aspects of pedestrian road accident victims in Shohada referral university hospital, East Azerbaijan province. *J Urmia Uni Med Sci.* 2014;25:549-60.

44. Taghipour H, Panahi F, Khoshmohabat H, Hojati Firoozabadi N, Moharamzad Y, Abbasi A. Causes and severity of fatal injuries in autopsies of victims of fatal traffic accidents. *SSU J.* 2010;17(5):358-64.
45. Akbari M, editor. National strategies for quality improvement in emergency management 2002: Proceeding of national conference on quality improvement in emergency medicine.
46. Misky GJ, Burke RE, Johnson T, del Pino Jones A, Hanson JL, Reid MB. Hospital readmission from the perspective of Medicaid and uninsured patients. *JHQ.* 2018;40(1):44-50.
47. Soroush AR, Makarem J, Yonesian M, Fazeli MS, Hajiabdolbaghi M, Noori M, et al. Surgical wound infection and factors affecting it in general surgery patients. *JIMC.* 2007;25(4):313-22.
48. Bozorgzad M, Hemati Z. Frequency of errors in nursing and associated factors in the cases referred to the Mortality Committee in Shahrekord University of Medical Sciences during 2006-2012. *J Clin Nurs Midwifery.* 2015;4(2): 52-8.
49. Jolae S, Hajibabae F, Peyravi H, Haghani H. Nursing medication errors and its relationship with work condition in Iran University of Medical Sciences. *J Med Ethics Hist Med.* 2009;3(1):65-76.
50. Rangraz Jeddi F, Farzandipour M, Mousavi S G A. Completion rate of data information in emergency record in Kashan's hospitals. *Feyz.* 2004; 8 (3) :68-73.
51. Mahabadi A, Ketabi S, Sajadi SM. Investigate the parameters which affect the patients waiting time in emergency department of orthopedic services in Ayatollah Kashani hospital with the lean management approach. *Health inform manag.* 2015; 11(7): 1016-25.
52. Hosseini M, Shaker H, Ghafouri H, Shokraneh F. Chronometric study of patients' workflow and effective factors on it in emergency department of 7th tir Martyrs hospital of Tehran, Iran. *J Health admin.* 2010;13(40):13-22.
53. Mock C, Nguyen S, Quansah R, Arreola-Risa C, Viradia R, Joshapura M. Evaluation of trauma care capabilities in four countries using the WHO-IATSI Guidelines for Essential Trauma Care. *World J Surg.* 2006;30(6):946-56.

Tables

Table 1**The participants' characteristics in specialized meetings to review the model components**

ID	Education	Degree	Job	Age²	Work experience³
1	Healthcare management	PhD	Faculty member	55	25
2	Health policy	PhD	Faculty member	30	2
3	Neurologist	MD	Faculty member	52	25
4	General practitioner	MD	Head of the provincial health center	51	23
5	Nurse	MSc	Assessor of treatment deputy in university	50	29
6	Emergency Medicine	MD	Faculty member	43	8
7	General practitioner	PhD	Researcher of RAPRC ¹	52	21
8	Emergency Medicine	MD	Faculty member	39	8
9	Nurse	PhD	Faculty member	52	24
10	Anesthesiologist	MD	Faculty member	45	10

1: Road Accident Prevention Research Center, 2,3: Numbers by year

PhD: Doctor of Philosophy; **MD:** Medicine Doctor

Table 2

Results of assessing general indicators

Indicator	Results(frequency or percent)	Description
Average length of stay of trauma victims (day)	5.8	Statistics related to road traffic patients were not available separately and the result was related to the trauma ward. The length of stay in ICU was 7.25 days.
The ratio of full-time emergency physicians to the number of patients	0.01	For every 55 patients, there was one emergency medicine specialist per shift.
The ratio of full-time emergency assistants to the number of patients	-	The number of assistants per shift varied.
The ratio of nurses to the number of patients in emergency department	0.13	There was one nurse for every seven patients. Adequacy confirmation required more assessment.
The ratio of patient carriers to the number of patients in the emergency department	0.12	There was one patient carrier for every eight patients. Adequacy confirmation required more assessment.
The ratio of cleaner staff to the number of patients in the emergency department	0.06	There was one cleaner staff for every 15 patients. Adequacy confirmation required more assessment.
The percentage of physicians working in the trauma emergency department who have completed ATLS and received a valid certificate	100%	-
The percentage of trauma nurses who have completed ATCN and received a valid certificate	84.05%	All nurses must take the required courses.
The ratio of resources required to manage airway, breathing, circulation, and shock (based on the WHO checklist (100%	-
The ratio of specific resources for special injuries management including head, neck, chest, abdomen, extremity, spinal, burns and wounds (Based on the WHO checklist (84.05%	Auto transfusion from chest tubes and topical antibiotic dressing were not adequate. Also, maintaining normotension and oxygenation to prevent secondary brain injury, portable X-ray was not existence.
Per capita physical space of the emergency department in proportion to the number of patients (daily on average)	5.4 square meters per patient in each shift	Physical space of the emergency room was 1815 square meters.

The number of death-related audits based on the latest version of ICD	3	Three of the eight deaths were related to road traffic patients' mortality audits.
The number of occurred errors	Bedsore(45) Medication errors(40) Registration errors(36) Other cases(19)	The recorded errors were 180 cases, and they only were related to nurses' errors.
The number of sessions held to examine the deaths of traumatic victims, and the number of approvals implemented based on it	3	Out of 50 approved approvals, three were related to road traffic patients in a year.
The number of quality improvement sessions to examine the problems related to providing service for traumatic patients and the number of approvals implemented based on it	0	-
The percentage of patients dispositioned in less than 6 hours	94.09%	The average time out of the emergency room was about four hours.
The percentage of successful CPR in traumatic patients	1.19%	This index was not calculated for eight months. It was not calculated separately for road traffic patients
The mortality rate of traumatic patients	10.45%	A total of 2124 road traffic patients were admitted to hospital, of which 222 patients died.
The number of the incidence of hospital complications	6	Only postoperative infection and bleeding were recorded.
The percentage of the visit or re-hospitalization in the emergency department	16.64%	The number of road traffic hospitalizations was 4228 and 707 were readmitted. The cause of readmission is not specified.
The ratio of road traffic mortality to the number of dead patients	9.11%	The total number of fatalities was 2435 and the number of fatalities due to accidents was 222 (in a year).
ATLS: the Advanced Trauma Life Support course; ATCN: the Advanced Trauma Care for Nurses course; ICD: International Classification of Diseases; CPR: Cardiopulmonary Resuscitation; ICU: Incentive Care Unit; WHO: World Health Organization		

Table 3**Demographic characteristics and hospital information of the patients**

Variable		Frequency (%)
Gender	Male	161(80.5)
	Female	39(19.5)
Mechanism	The collision of vehicles with pedestrian	100(50)
	The collision of vehicles with each other	42(21)
	The collision of vehicle with motorcycle	25(12.5)
	The vehicle and motorcycle overturning	15(7.5)
	Other	18 (9)
Location of injury	Head and face	67 (33.5)
	Arms and hands	33(16.5)
	Neck	19(9.5)
	Chest and abdomen	3(1.5)
	Posterior trunk (the back and spine)	5(2.5)
	Pelvis	7(3.5)
	General weakness	10(5)
	Multiple trauma	44(22)
Triage level	Level 1	12(6.06)
	Level 2	44(22.22)
	Level 3	142(71.72)
Documentation	Completeness of the patient document	87(43.5)
	T record	91(45.5)
	SO2 record	43(21.5)
	PR record	14(7)
	RR record	43(21.5)
	BP record	20(10)
	GCS record	170(85)
Some clinical procedures	Pulse oximetry	182(91)

	Chest tube	6(3)
	Intubation	5(2.5)
	Muscular skeletal checking	188(94)
	DPL	3(1.5)
	Fracture fixation	29(14.5)
	Blood transfusions and blood products	20(10)
	Outpatient surgery	62(31)
	Heparin and enoxaparin injection	4(2)
Outcome	Discharge with medical advice	104(52)
	Discharge against medical advice	9(4.5)
	Escape	2(1)
	Dispatch to another medical center	56(28)
	Hospitalization in inpatient wards	27(13.5)
	Hospitalization in incentive unit care	2(1)
Para clinical services	CT scan	59(31.72)
	CXR	67(36.02)
	FAST	115(61.82)
	Abdominal and pelvic ultrasound	2(1.07)
	ECG	5(2.68)

T: Temperature; **S02:** Saturation of Oxygen; **PR:** Prothrombin Ratio; **RR:** Respiratory Rate; **BP:** Blood Pressure; **GCS:** Glasgow Coma Scale; **DPL:** Diagnostic peritoneal lavage; **CT:** Computerized tomography; **CXR:** Chest X-Ray; **FAST:** Focused Assessment with Sonography for Trauma; **ECG:** Electrocardiogram

Table 4

Waiting time of preclinical services and outcomes

Service		Median (minute)	Min	Max
Para clinical services	CT	54	4	324
	CXR	36	4	280
	FAST	35	6	195
	Sonography	32.5	6	55
	ECG	30	10	135
Outcome	Discharge	170	21	1111
	Dispatch to another medical center	151.5	50	720
	Hospitalization in normal wards	189	10	1709
	Hospitalization in special wards	720	240	1200

CT: Computerized tomography; **CXR:** Chest X-Ray; **FAST:** Focused Assessment with Sonography for Trauma, **ECG:** Electrocardiogram

Table 5

The quality of some of the procedures performed on the patient

Item	Likert degree					
	Frequency (%)					
	Very good	Good	Medium	Poor	Very poor	
Chest tube						
1	Selecting the correct cutting location and tube size		1(16.67)	5(83.83)		
2	Identifying the location of the tube		4(66.67)	2(33.33)		
3	Inserting the tube		4(66.67)	2(33.33)		
4	Fixation		5(83.83)	1(16.67)		
5	Functional check		4(66.67)	1(16.67)	1(16.67)	
Intubation						
1	Providing equipment, laryngoscope checks and medications, appropriate size of endotracheal tube		1(20)	4(80)		
2	The correct way to get an ambo bag		5(100)			
3	Correct drug injection sequence		5(100)			
4	Appropriate laryngoscopy		5(100)			
5	Proper tube placement		4(80)	1(20)		
6	Endotracheal tube fixation and proper lung ventilation check		5(100)			
Blood and fluid transfusions						
1	Checking patient characteristic		20(100)			
2	Checking the blood product and patient's blood type		20(100)			
3	Matching delivered blood type and patient blood type		20(100)			
4	Recording the date and duration of the injection		19(95)	1(5)		
Splinting						
1	Providing wound cleansers (if available)		14(48.28)	13(44.83)	2(6.9)	

2	Suitable analgesia for the patient	15(51.72)	12(41.38)	2(6.9)
3	The right size splint	23(79.31)	3(10.34)	3(10.34)
4	Proper installation (observing the top and bottom of the splint - how to get the limb)	21(72.41)	2(6.9)	6(20.69)
5	Limb pulse check after implantation	20(68.97)	2(6.9)	7(24.14)
Patient satisfaction				
1	waiting time	152(76)	3(1.5)	45(22.5)
2	Physician skills and behavior	182(91)		18(9)
3	Nurse skills and behavior	187(93.5)		13(6.5)
4	Supplies and equipment	188(94)		12(6)

Figures

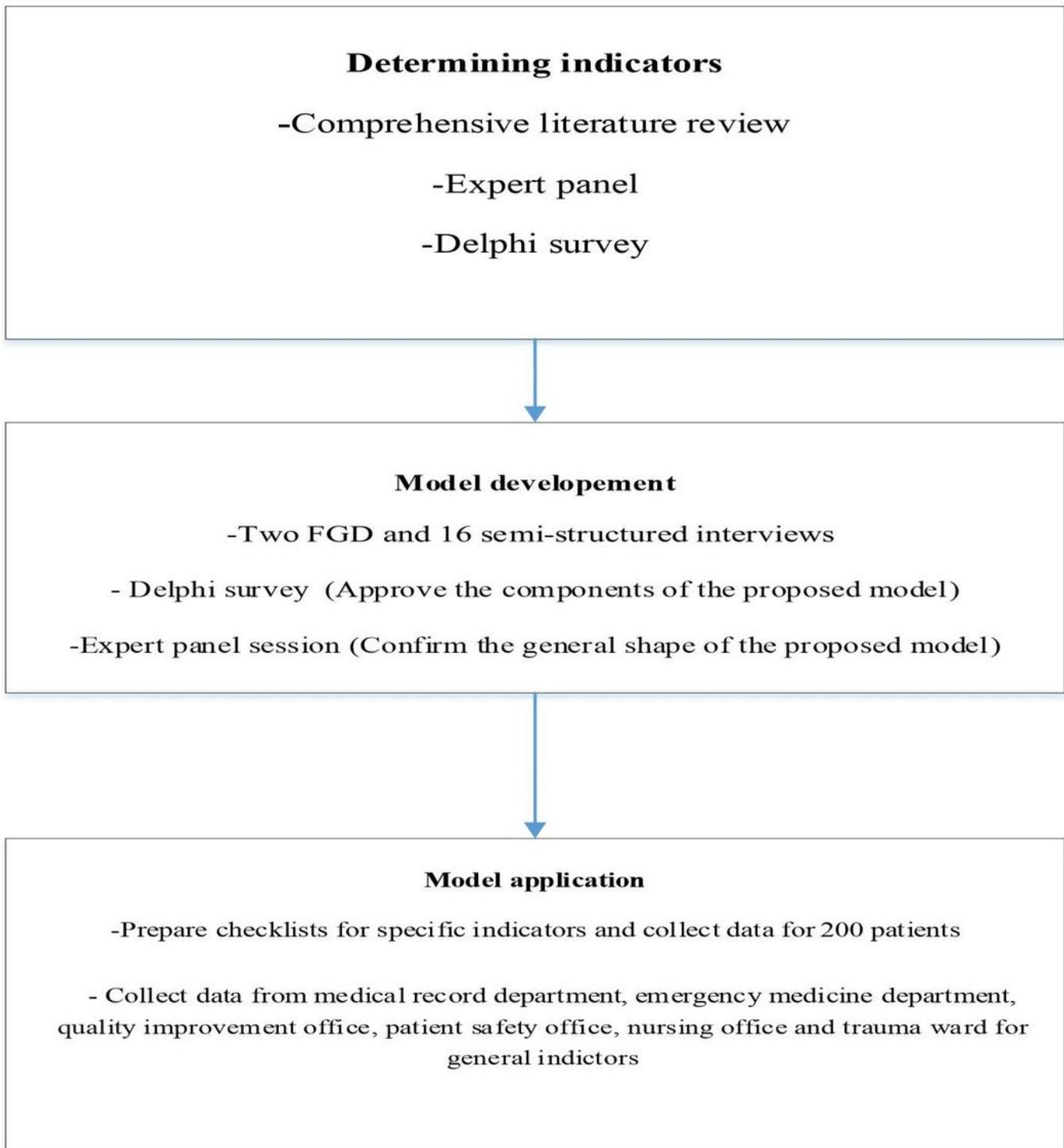


Figure 1

Flowchart of study procedure

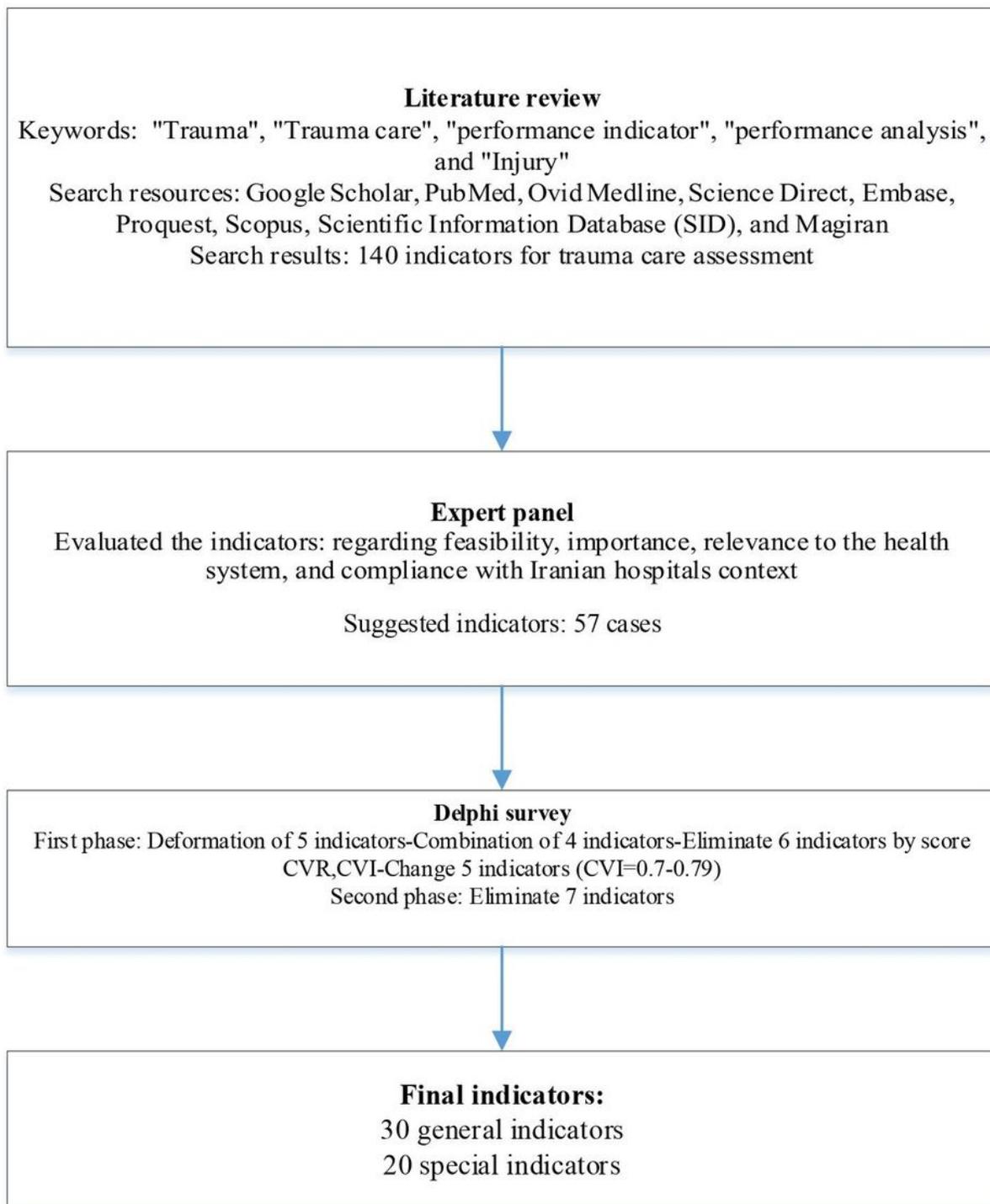


Figure 2

Flowchart of determining indicators

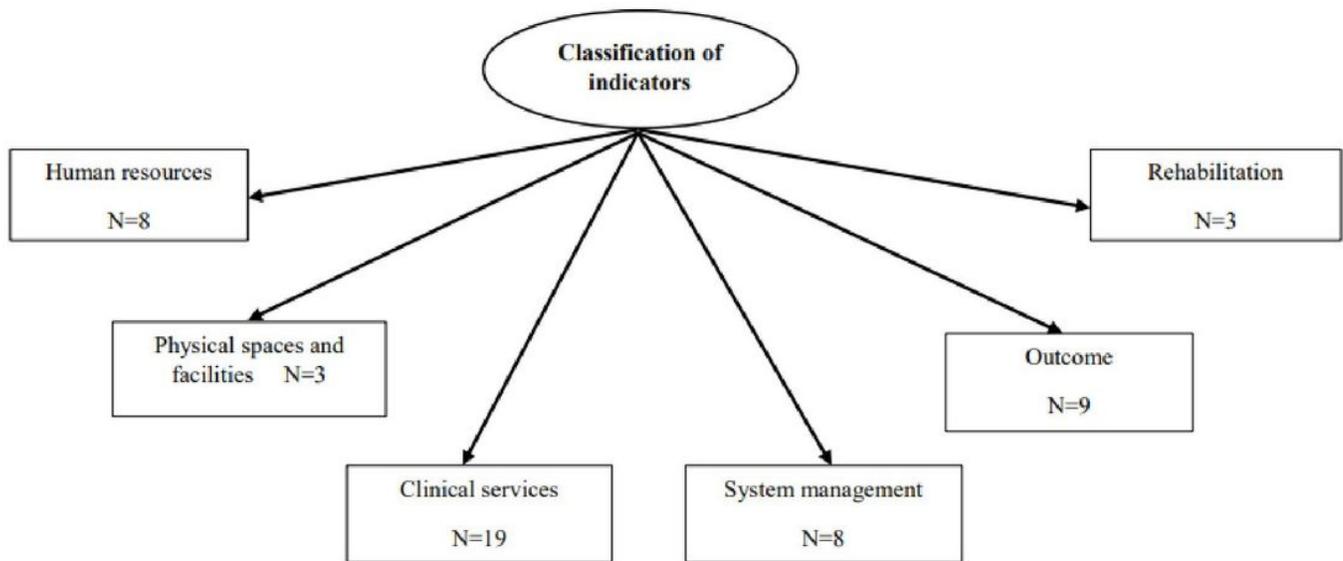


Figure 3

Classification of trauma care indicators for assessment

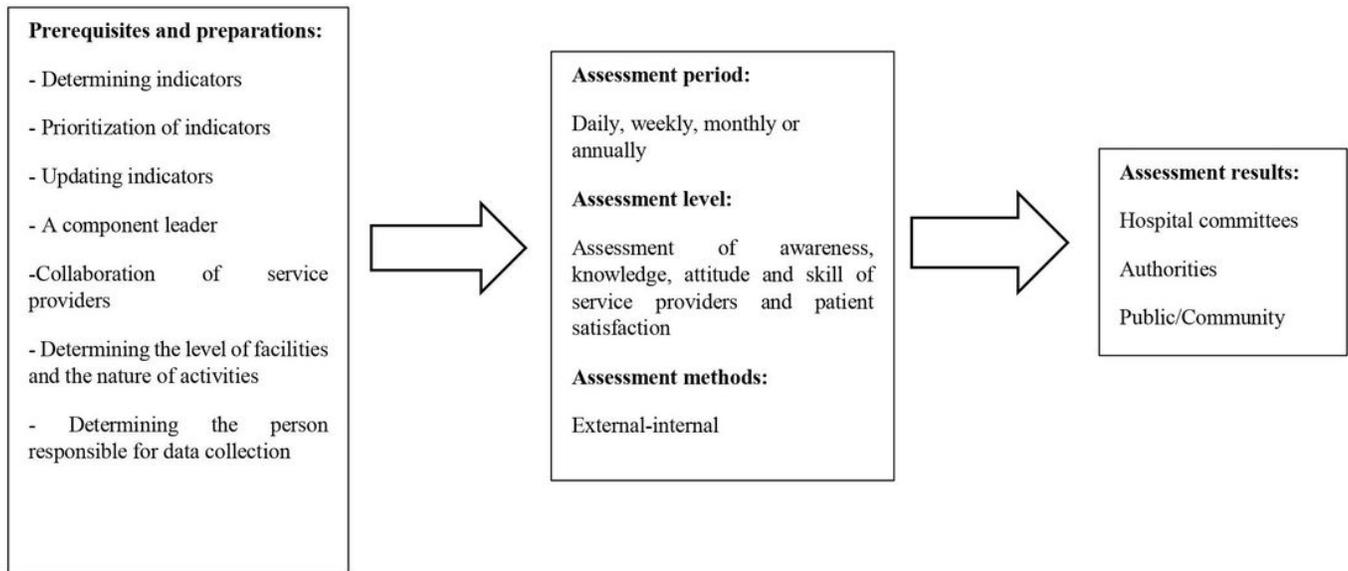


Figure 4

The FGDs and interviews finding

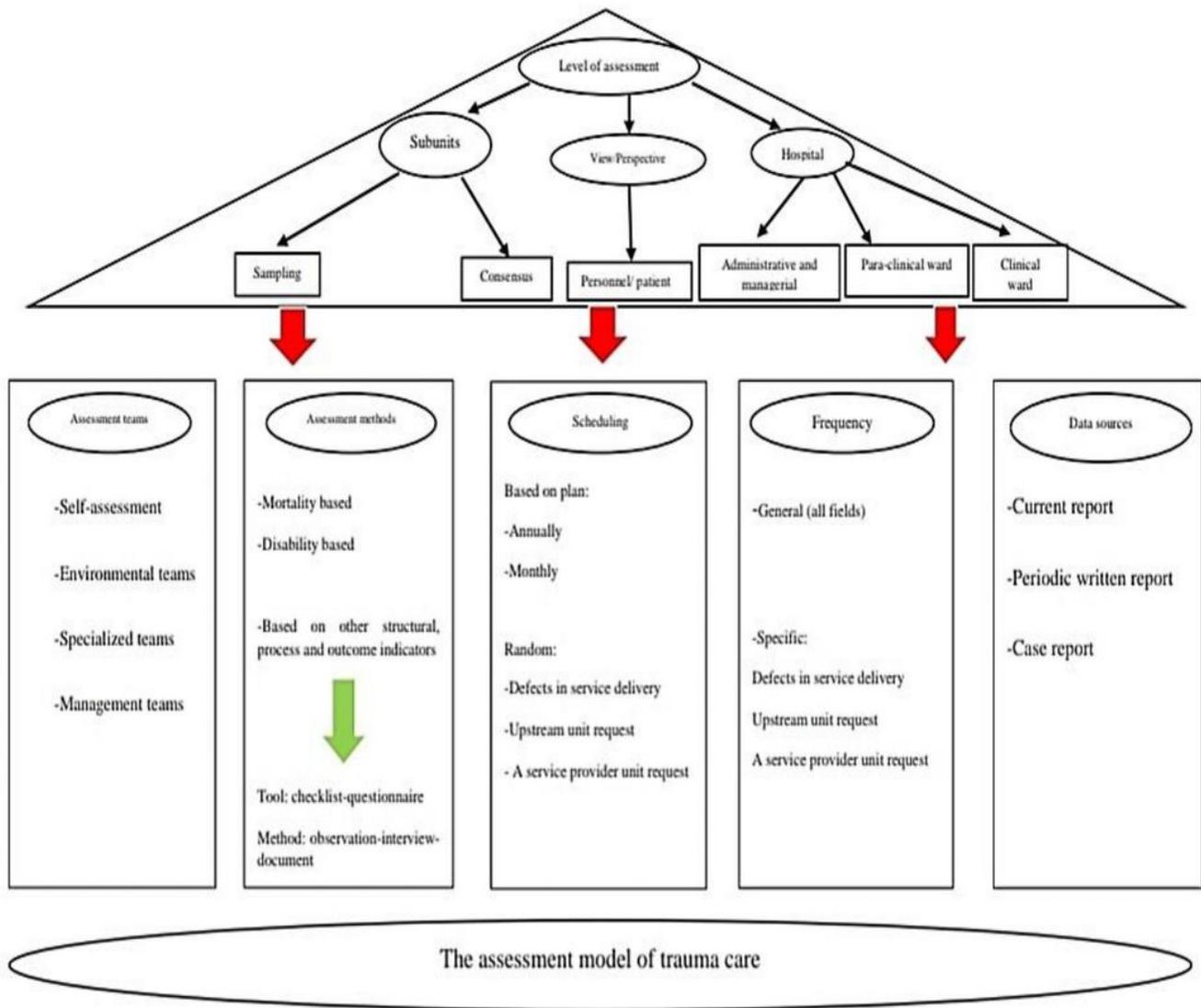


Figure 5

Assessment Model for in-Hospital Trauma Care