

Developing Performance Indicators for Trauma Care: A Four-Stage Qualitative Study

Yalda Mousazadeh ^{1,2}, Homayoun Sadeghi-Bazargani ³, Ali Janati ^{4 *}, Mahboub Pouraghaei ⁵

¹ Department of Health Services Management, Faculty of Management and Medical Informatics, Tabriz University of Medical Sciences, Tabriz, Iran

² Student Research Committee, Tabriz University of Medical Sciences, Tabriz, Iran

³ Road Traffic Injury Research Center, Tabriz University of Medical Sciences, Tabriz, Iran

⁴ Iranian Center of Excellence in Health Management (IceHM), School of Management and Medical Informatics, Tabriz University of Medical Sciences, Tabriz, Iran

⁵ Emergency Medicine Research Team, School of Medicine, Tabriz University of Medical Sciences, Tabriz, Iran

* **Corresponding Author:** Iranian Center of Excellence in Health Management (IceHM), School of Management and Medical Informatics, Tabriz University of Medical Sciences, Tabriz, Iran.

Email: janati1382@gmail.com

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Abstract

Background: Trauma is considered one of the major causes of death around the world. Increased costs of healthcare and differences in the quality of services among trauma centers indicate that measuring the performance of trauma care is necessary.

Objectives: the present study aimed to develop some trauma care performance indicators.

Methods: This study was implemented between September 2017 and October 2018 in a four-stage process: a comprehensive literature review, sessions with a panel of five experts, two focus group discussions and sixteen semi-structured interviews, and a two-round Delphi survey. The study setting was East Azerbaijan province, Iran. Forty-six experts in different fields of medical sciences confirmed applicable indicators for trauma care assessment.

Results: A total of 140 indicators were found through a comprehensive literature review. After conducting expert panels, focus group discussions, and interviews, the number of indicators decreased to 57 cases and were entered into the Delphi survey. In the first phase of the Delphi survey, content validity ratio (CVR), content validity indicator (CVI), and modified kappa values were 0.64, 0.85, and 0.83, respectively. Sixteen indicators were changed or deleted and 6 indicators were separated. The members of the final expert panel agreed on 50 indicators in the second phase of the Delphi survey after omitting 7 indicators.

Conclusion: Performance indicators for trauma care evaluation were introduced in this study. They can be used by policymakers and health service providers to assess and improve performance and compare trauma centers in Iran and developing countries that have health systems similar to the Iranian health system.

Keywords: Trauma Care, Performance Indicators, Hospital.

Introduction

Trauma is considered to be the major cause of death occurring in the first four decades of life. It affects the most active groups of the community (1). The annual death rate caused by trauma is estimated to be around 6 million people, and trauma is a main factor of the universal burden of disease. Major traumatic patients often suffer from serious and several injuries associated with their mortality and disability probability (2). This disease (trauma) does not differentiate between developed or underdeveloped countries; it is a main challenge to modern cultures (3). Trauma is a more acute and thought-provoking problem in developing countries, possibly due to the lack of a structured

trauma system and the extent of events leading to trauma, for example, traffic accidents (4).

While injuries are one major cause of mortality, many patients are severely affected; they are more likely to survive and return to life if they are managed well in an organized care system consisting of paramedics, specialists and physicians, and rehabilitation services (5). The goal of health organizations is to provide cost-effective, patient-oriented, effective, and safe health services at a specified time and in the right place. However, there is a lot of evidence indicating that patients do not always receive the best care. Some problems have been reported in hospital emergencies, such as long waiting times, a lack of medical priorities through triage, and inadequate physical space in the emergency

department (6). These problems will certainly affect trauma patients as well. Furthermore, it is indicated that differences in providing care for common injuries exist in similar areas and systems. It is possible that about 15% of deaths caused by trauma can be prevented. It has been shown that the quality of care provided to patients needs to be improved (7, 8). Indeed, the reason for this wide gap in the clinical performance of trauma centers has not been identified (9). It seems the intellectual efforts to improve quality and protect patient safety can improve patient-related outcomes, reduce healthcare costs, and shorten the gap (10).

Given the recent considerable increase in healthcare costs and differences in the quality of services, health officials around the world emphasize the urgent need to gain information on healthcare (4). Quality improvement programs monitor the quality and performance continuously (if it is below the standard level). Key performance indicators form one part of the care program and are used to measure and compare the performances of trauma centers. Collecting information on processes and outcomes in a structured form is necessary in order to improve programs and enhance the quality of trauma systems (11).

Quality assessment of medical care has often failed to establish the standards. Indeed, caregiving programs have little chance for improvement unless they are measured properly. The lack of appropriate indicators is because of the complexity of many aspects of medical care (12). The goal of performance indicators is to improve the quality of an organization. Clinicians and managers provide intra-system indicators for monitoring the outcomes, matching guidelines, specific aspects of care, and performance benchmarking. They also provide the conditions for comparing centers that have the same conditions. In systems where investment depends on performance, the indicators should be carefully selected and should reflect the important goals of healthcare (13).

There is a lack of evidence on the ability to generalize and interpret the information used by healthcare managers and physicians (14). The indicators often reflect the common perception, rather than evidence-based practice. Unfortunately, the validity and reliability of indicators for measuring trauma care and their effectiveness in improving performance have remained unknown (5). Chiara et al. asserted that preventive death is a good indicator, but the use

of experts' opinions is questionable for the identification of cases (15).

A system of performance assessment and monitoring has had a dramatic impact on the performance of various management systems over recent years. The Trauma Committee of American Surgeons College was one of the first organizations to develop indicators to assess quality of care. These indicators initially included 12 audit filters, but their numbers increased after being reviewed by experts (16). Many developing countries lack an accreditation process for trauma centers; nor do they have standard and specific assessment tools (17). Iran's Ministry of Health and Medical Education defined five criteria as hospital emergency performance indicators for evaluating performance in emergency departments, which were the percentages of patient disposition within six hours and patient disposition within twelve hours, unsuccessful cardio-pulmonary resuscitation (CPR), discharge against medical advice, and mean triage time (18). While the indicators proposed by Iran's Ministry of Health are measurable and realistic, they focus more on the clinical area and are not specific to trauma care. Some studies have recommended using context-related audit filters in the area of health services provision (19).

Objectives

The present study aimed to identify the indicators related to trauma care in the Iranian hospital context based on scientific evidence and the views of experts.

Materials and Methods

This study, conducted between September 2017 and October 2018, was derived from a border project to develop a hospital performance assessment model for the management of patients with traffic injuries. It was implemented in a four-stage process: a comprehensive literature review, sessions with a panel of five experts, two focus group discussions and sixteen semi-structured interviews, and a Delphi survey in two phases.

Literature review

A comprehensive literature review was conducted on the databases of Google Scholar, PubMed, Ovid Medline, Science Direct, Embase, Proquest, Scopus, Scientific Information Database (SID), and Barakat Knowledge Network System using the keywords "Trauma", "Trauma care", "performance indicator", "performance analysis", and "Injury" and

combinations of these keywords. Persian databases were also searched without considering the time interval. Moreover, the trauma-specific database of Safetylit, the World Health Organization website, national and international guidelines on trauma care, reliable reports related to trauma care, and Cochrane Collaboration and Evidence-Based Medicine were reviewed. Articles referring to trauma care assessment were selected; any duplicate articles were removed. Subsequently, articles that did not refer to trauma care indicators were excluded. Books and guides related to trauma care were reviewed for possible indications. Finally, indicators were categorized by content.

Expert panel

In the second phase of the study, a panel of five experts evaluated the indicators regarding feasibility, importance, relevance to the health system, and Iranian hospitals. Panel members included research team members, stakeholders, and foreign specialists, including two healthcare management specialists, one epidemiologist, three general physicians, one emergency medicine specialist, two nurses, one anesthetist, and one neurologist. The panel members were selected based on the purposive sampling method and the following factors: having the knowledge and expertise required in the field of evaluating and developing hospital performance indicators, operating in hospital emergency departments, having the required expertise in trauma care, having researched in areas related to trauma care, and, most importantly, being willing to participate in the panel sessions. The panel sessions lasted two hours on average and were run in the form of discussion. The experts recorded their suggestions regarding changes in the indicators on the forms provided for them before the session. Then, these forms were collected and the information was summarized.

Focus group discussions and interviews

In the third phase of the research, two focus group discussions were held and sixteen semi-structured interviews were performed to complete the information of the previous stage. Each session was held with six participants (a total of 12 people). Indicators proposed by the participants (if not repetitive) were added to those derived in the previous stages. Each interview lasted 45 to 60 minutes, and each focus group discussion lasted 60 to 90 minutes. The individuals were selected based on purposive sampling. The 28 participants in the group discussions and interviews included the following

people: emergency medicine specialist (4), orthopedic specialist (3), anesthesiologist (1), general surgeon (2), neurologist (2), internist (1), general physician (4), nurse (6), epidemiologist (1), health services management (3), and medical records expert (1).

Delphi Technique

The indicators identified over and through the previous stages were entered into the Delphi survey to assess the content validity from the perspective of 30 experts. The indicators were examined in this stage based on the four criteria of necessity, relevance, clarity, and simplicity. The studied individuals included general physician (2), anesthesiologist (1), nurse (4), emergency medicine specialist (9), orthopedic specialist (2), internist (1), neurologist (2), PhD in Health Information Technology (3), PhD in Health Services Management (3), PhD in Health Policy (2), and PhD in Health in Disasters and Emergencies (1). The questionnaires were distributed to the participants, and the necessary explanations were given by the researchers. The deadline for filling out the questionnaire was determined to be two weeks.

Content validity indicator (CVI) and content validity ratio (CVR) were surveyed from the viewpoint of 30 experts to confirm content validity (20). In order to calculate the content validity indicator using Waltz and Bausell's method (21), the three criteria of "relevancy to subject," "simplicity", and "clarity" were examined based on the four-point Likert scale (completely relevant, relevant, relatively relevant, and not relevant) using the following formula:

$$CVI = (\text{sum of agreement of scores for each item ranked 3 and 4}) / (\text{total number of specialists})$$

In this method, each item with a score higher than 79% was considered appropriate. Items scoring between 70% and 79% needed to be corrected, and items with a score less than 70% were unacceptable. Based on the mean scores of the indicators, the mean content validity indicator (content validity indicator/ averaging calculation method) was calculated.

To determine the content validity ratio as designed by Lawshe (21), each of the indicators was examined on a three-point Likert scale regarding "necessity" (necessary, useful but not necessary, and not necessary) by 30 experts. The formula used to calculate the content validity ratio was:

$$CVR = (\text{number of people who selected the option "necessary"} (3) - (\text{total number of specialists}/2)) / (\text{total$$

number of specialists/2)

An acceptable CVR was 0.33 according to the number of participants in the Delphi survey, which were 30 people.

To calculate the modified kappa, the odds ratio of agreement was first calculated (21) using a binomial random variable formula:

$$p_c = \left[\frac{N!}{A!(N-A)!} \right] \cdot 5^N$$

where N is the number of specialists, and A is the number of people who agree (the number of people who selected options 3 and 4 in each criterion). In the next step, the kappa coefficient was calculated based on the following formula:

$$k = \frac{I - CVI - P_c}{1 - P_c}$$

Based on the view of Polit and Beck (21), a kappa coefficient in the range of 0.40-0.59 was at the fair level, between 0.60-0.74 was at the good level, and above 0.75 was at the high level.

Final expert panel

In the second phase of the Delphi, the indicators were presented regarding the scores CVI, CVR, modified kappa, and the changes requested by the experts were proposed in the final panel session to apply the final view. The panelists consisted of two experts with PhDs in health services management, one epidemiologist, two emergency medicine specialists, one general physician, and one nurse. Indicators were categorized and presented after applying the final view. Excel 2016 software was used for statistical analysis in the Delphi survey.

Ethical consideration

This study was derived from a PhD thesis. The main protocol of the research was reviewed by the Ethics Committee of the Research Deputy of Tabriz University of Medical Sciences and approved under the code IR.TBZMED.REC.1396.560. All people in the research participated with informed consent, and informed consent forms were completed by all participants in the panel sessions, interviews, focus group discussions, and Delphi survey.

Results

A total of 50 trauma care indicators related to Iranian hospital settings and facilities were presented based on four stages in this research using various methods (comprehensive literature review, experts' panel sessions, focus group discussions, semi-structured interviews, and the

Delphi survey). The study process is presented in Figure 1.

In a comprehensive literature review, 102 articles were obtained. Seventeen were excluded for being duplicate articles, and 43 articles did not provide clear information on trauma care indicators. Totally, 51 articles, 3 guides, and 2 books related to the purpose of the study were selected and their findings reported. Finally, 140 indicators for trauma care were identified and categorized in 12 areas based on the content, including general indicators (2), outcome (13), diagnostic services (12), clinical services (53), resources and facilities (8), physical space (11), human resources (9), pre-hospital (8), post-hospital or rehabilitation (5), system management (9), documentation (9), and service recipients (2) (Table 1).

The identified indicators were reviewed in 5 expert panel sessions, during which panelists suggested that some indicators be excluded, some be merged, and the appearance of some indicators be changed. The reasons for changes in the indicators to be applied were as follows:

- Experts emphasized the development of more general indicators to facilitate comparing the services provided among health centers.

Adequate data, including physically or electronically recorded data is lacking, and some information is recorded incorrectly, which cannot be used and judged.

- Adequate facilities including human resources, time, and financial resources to collect information are lacking.

- Some of the identified indicators for trauma care are non-specific.

- Some indicators in the outcome of trauma care are not important.

- The executive and management systems of Iran and those of other countries are different.

To collect the complementary view of experts, focus group discussions and semi-structure interviews were held, which led to 30 indicators being proposed at this stage. Out of these 30 indicators, 22 were repetitive (based on the literature review). The remaining 8 indicators, which included the manner of transferring patients to the hospital, the knowledge of ambulance officers, the adequacy of ambulance facilities, the performance of the patient-guiding headquarters, the presence of clinical guidelines, proper triage, bedside ulcer care, and social worker interventions for traumatic patients (including home visits), were added to the previous ones.

After the previous stages were completed, 57 indicators were finally confirmed and classified by the research team. These indicators were classified into the 8 classes of human resources, physical space and facilities, pre-hospital, indicators related to diagnostic services, clinical services,

system management, outcome, and rehabilitation. The highest frequency of indicators was related to the service process, and the lowest frequency was related to diagnostic services indicators.

CVR, CVI (for content validity), and modified kappa (with the aim of evaluating reliability among the observers) were calculated in the first phase of the Delphi survey as 0.64, 0.85, and 0.83, respectively. Out of the 57 proposed indicators, the format of 5 indicators was modified by the qualitative views of the experts. The modified form of these five indicators included the presence of a multi-specialized trauma team, the

availability of required resources for airway management, respiration, circulation, and shock (based on the WHO checklist), the availability of specific resources for management of special injuries (based on the WHO checklist), the presence of a tonometer for correct identification and management of the compartment syndrome, and the number of death-related audits according to ICD (International Classification of Diseases). Six indicators were separated based on the recommendation of the experts (Table-2).

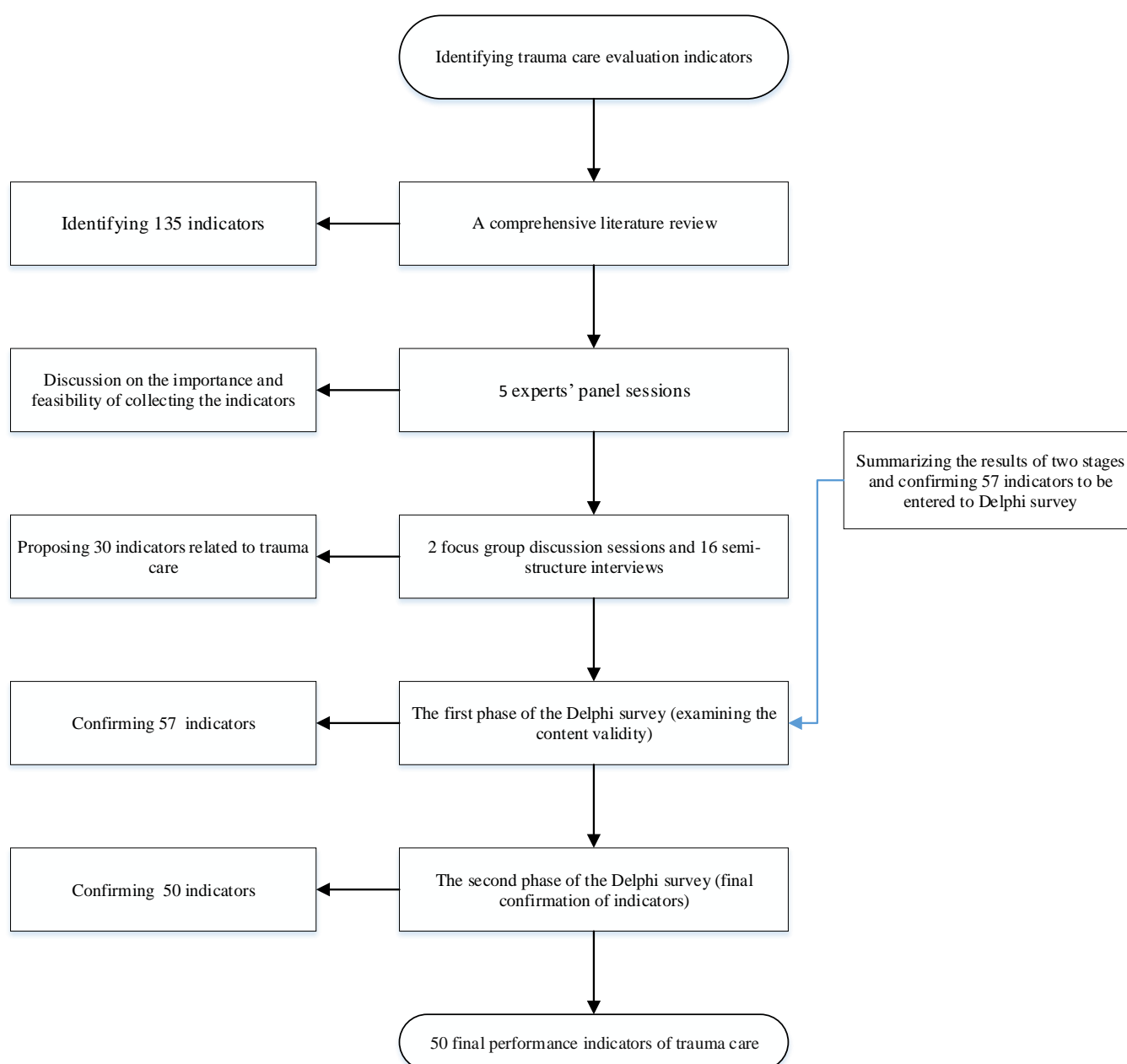


Figure-1. Flowchart of the study process

Table-1. trauma care indicators based on literature review

Number	The indicator	Specific domain	References
1	The average length of stay	General	(8)(22)(23)(24)(25)(26)
2	The rate of traumatic injuries due to other injuries	General	(27)
3	Multi-specialist trauma team	Human resources	(24)(27)(28)(29)
4	The average time of trauma team recovery (attending at a patient's bedside)	Clinical services	(26)(30)
5	The proportion of non-physician human resources (including nurses, patients' transporters, crew) to the total personnel	Human resources	(31)
6	Emergency department staff participation in continuous training courses	Human resources	(7)
7	Number of skill-based training courses (workshop-practical) in the emergency department	Human resources	(31)
8	The required knowledge and skills to manage the airway, breathing, circulation and shock	Human resources	(24)(32)
9	Evaluation of staff performance and providing annual feedback	Human resources	(7)
10	Protocols for referral of patients to rehabilitation centers	Post-hospital	(4)(8)
11	The number of transferred patients to in-patient rehabilitation facilities	Post-hospital	(4)(33)
12	Assessment of patient's functional status (at discharge and afterwards with tools such as WHODAS, GOS, etc.)	Post-hospital	(19)(24)(34)(35)
13	Various hospital visits	Post-hospital	(12)(24)
14	Mortality rate of patients at the scene of the accident	System management	(33)
15	Mortality rate of patients in unplanned treatment facilities	System management	(24)(33)
16	Patient autopsy rate	System management	(33)
17	Determining the survival probability of patients	System management	(33)
18	Investigation of patient issues by the quality improvement system	System management	(33)(36)
19	Performing hemoglobin diagnostic test	Diagnostic services	(7)
20	Measuring end-tidal CO ₂ in intubated patients and attached to oxygen ventilation	Diagnostic services	(11)
21	Performing X-Rays on various injuries	Diagnostic services	(7)
22	Performing computed tomography (CT scan) on multiple injuries	Diagnostic services	(2)(7)
23	The average time of performing computed tomography	Diagnostic services	(2)(7)(8)(14)(16)(24)(26)(30)(37)
24	Diagnosis all injuries	Diagnostic services	(8)(11)(19)(24)(26)(37)
25	Performing biopsy and radiography of wounds	Diagnostic services	(11)
26	Performing hematocrit test	Diagnostic services	(7)
27	Average duration of performing required tests	Diagnostic services	(38)
28	Performing creatine kinase test	Diagnostic services	(11)
29	Secondary evaluation of the patient	Diagnostic services	(19)
30	The rate of transferring needful patients to higher level trauma centers as their need	Pre-hospital	(4)(39)(40)
31	Transmission rate of patients with spinal cord injuries to acute spinal cord treatment centers	Pre-hospital	(4)(15)(16)(41)
32	Transmission rate of patients by ambulance services	Pre-hospital	(19)
33	Available resources for management of airway, breathing, circulation and shock	Resources and facilities	(19)(32)(42)(43)
34	Special resources measures for head and neck injuries	Resources and facilities	(19)(42)(43)
35	Special resources and facilities for chest injuries	Resources and facilities	(19)(42)(43)

36	Special resources and facilities for abdominal injuries	Resources and facilities	(19)(42)(43)
37	Special resources and facilities for lower extremities injuries	Resources and facilities	(19)(42)(43)
38	Special resources and facilities for spinal cord injuries		(19)(42)(43)
39	Special resources and facilities for burnings and wounds	Resources and facilities	(19)(42)(43)
40	Number of adverse event	Outcome	(12)(24)(36)
41	Deposition of trauma patients	Outcome	(34)(44)
42	Mortality rate	Outcome	(8)(12)(16)(23)(24)(26)(29) (36) (41)
43	Unplanned return of the patient to Intensive Care Unit	Outcome	(8)(12)(24)(26)
44	Mortality rate 30 days after injury	Outcome	(45)
45	Complications rate (such as respiratory infection, hospital complications, cardiac arrest, pneumonia, bedsores, loss of consciousness, etc.)	Outcome	(7)(8)(14)(16)(23)(26)(46)(47)
46	Preventable mortality rate	Outcome	(7)(25)(26)(39)(44)
47	Re-intubations less than 48 hours after extubation	Outcome	(7)(16)(22)(23)(24)(47)
48	Unplanned return to the surgery room within 48 hours	Outcome	(16)(22)(24)
49	The illness burden due to the trauma patients	Outcome	(12)
50	Mortality rate after risk adjustment based on severity of injury	Outcome	(48)
51	Patient survival probability using TRISS scale	Outcome	(33)(49)
52	Number of occurring deaths one hour after transferring to the ward (not emergency department)	Outcome	(4)
53	Number of successful cases of resuscitation	Outcome	(7)
54	Number of conferences about investigating mortality	System management	(26)(50)
55	Service quality audits	System management	(26)(50)
56	Protocols to evaluate and report quality of trauma care	System management	(26)(50)
57	Adequate physical space for the emergency department	Physical space	(51)
58	Existence of a triage room with enough physical space about 20 square meters	Physical space	(51)
59	Existence of a resuscitation room with sufficient physical space about 35 square meters	Physical space	(51)
60	Acute treatment room with adequate physical space about 10-20 square meters	Physical space	(51)
61	Space for intensive care	Physical space	(51)
62	Short-term hospitalization space	Physical space	(51)
63	Available space for the treatment room	Physical space	(51)
64	Existence of isolated room	Physical space	(51)
65	Outpatient surgery room with 16 to 20 square meters	Physical space	(51)
66	Ready emergency room for emergency patients	Physical space	(39)(51)
67	Existence of facilities related to the trauma center level	Physical space	(51)
68	Satisfaction of referred trauma patients to the emergency department	Service recipients	(31)(39)
69	Patient rights compliance (from a patient perspective)	Service recipients	(31)
70	Completed report of emergency medical services	Documentation	(50)
71	Recording the severity of the injury in the patient database	Documentation	(24)
72	Recording medical history and nursing notes, anesthesia sheet and operating room	Documentation	(52)
73	Time recording in the surgery room	Documentation	(53)
74	Hourly documentation of vital symptoms of the patient	Documentation	(47)

75	Reports on the quality of care provided by specialists	Documentation	(7)
76	Documentation of neural caring status of patients with head, skull, and spinal cord injuries	Documentation	(16)(24)(47)
77	Hourly chart documentation starts with the patient entering the ward and ends by admitting the patient to the operating room, intensive care unit, death or transfer to another hospital	Documentation	(16)(47)
78	Loss of less than 10% of data according to the emergency department protocol	Documentation	(54)(55)
79	Number of physicians who have completed advanced trauma life support courses and received the certification	Human resources	(43)
80	Key treatments for all the patients (safe airway insertion, bleeding control, fracture fixation, physical examination, examining surface of the body, neuromuscular status, need for referral, etc.)	Clinical services	(11)(19)(23)(39)(56)
81	Patient vital signs control immediately after entering to the emergency department (pain score, respiratory rate, blood pressure, temperature, saturation of oxygen, glasgow coma scale)	Clinical services	(11)(12)
82	Timely thoracic surgery, brain surgery and emergency abdominal surgery and vascular surgery as soon as the patient arrives at the emergency department	Clinical services	(11)(24)(29)(39)(47)
83	Betadine (Povidone-iodine) for open wounds	Clinical services	(11)
84	Injection of tetanus vaccine for infected wounds	Clinical services	(11)
85	Controlling patient pain by reducing pain score to less than 4 in the pre-hospital phase and entering the emergency department	Clinical services	(11)(50)
86	Patient bleeding control	Clinical services	(4)(11)
87	Take necessary measures (airway insertion, serum therapy) in traumatic burn patients	Clinical services	(11)
88	Correct patient triage based on existing protocols	Clinical services	(11)(50)(56)
89	Antibiotic prescription for open fractures	Clinical services	(24)
90	Performing correct transfusion (blood infusion and generations of platelet and blood) in traumatic patients	Clinical services	(24)
91	Draining the hematoma in the shortest possible time	Clinical services	(24)
92	Treatment of ischemic limb in the shortest possible time	Clinical services	(7)(26)(50)
93	Dislocation treatment	Clinical services	(26)(50)
94	Prevention of thromboembolism (for example, using a preventive sock against thromboembolism, using heparin)	Clinical services	(11) (26)(50)
95	Assessment and immobilization of spinal cord if it is needed	Clinical services	(50)
96	Surgical treatment of open fracture	Clinical services	(38)
97	Using an pulse oximeter	Clinical services	(57)
98	Examining the occurrence of pelvic fracture (by CT scan or radiography)	Clinical services	(57)
99	Examining internal hemorrhage (CT, DPL, etc.)	Clinical services	(57)
100	Neurological status of brain in the four upper and lower extremities	Clinical services	(57)
101	Assessment of hypothermia	Clinical services	(57)
102	Performing required tests and radiography for the patient	Clinical services	(57)
103	Presence in the accident scene in less than 20 minutes	Pre-hospital	(9)(16)(24)(26)(33)(47)(56)
104	Identifying triage level above or below the patient injury level (re-triage)	Clinical services	(56)
105	Non-therapeutic laparotomy	Clinical services	(53)
106	Comatose patients with appropriate airway insertion at the time of leaving emergency	Clinical services	(16)(24)(41)(47)(58)(59)

107	Treatment of multiple fractures in the shortest possible time	Clinical services	(52)
108	Pre-hospital length	Pre-hospital	(9)(24)(39)(60)
109	Trauma patients with a GCS score less than 9 that were intubated	Clinical services	(7)(14)(26)
110	Fixing femur fracture in adult traumatic patients	Clinical services	(14)(29)(59)
111	A visit by surgeon when the severity of the injury is above 15	Clinical services	(24)
112	The existence of a trauma registry	Resources and measures	(8)
113	Protocols for proper transfusions	Clinical services	(7)(8)
114	Protocols for transferring patients between health centers	Clinical services	(12)(56)
115	Treatment for multiple tibial fractures or joint openings at least time	Clinical services	(16)(29)(47)
116	Admitted patients to centers where there is no surgeon or attending physician	Clinical services	(16)(47)
117	All the patients that are received platelet or plasma within 24 hours, after receiving at least 8 units of red blood cells or plasma	Clinical services	(16)
118	Trauma nursing core course for nurses	Human resources	(42)
119	Patients with severe trauma treated at an organized trauma center	Clinical services	(33)
120	Immobilizing unstable pelvic fractures	Clinical services	(4)
121	Surgery of long bone fracture in the shortest possible time	Clinical services	(4)
122	Epidural hematoma surgery in the shortest possible time	Clinical services	(4)
123	Surgery of broken femur in the shortest possible time	Clinical services	(4)
124	Prevention of lowering body temperature	Clinical services	(4)
125	Identifying the cause and treatment of shock	Clinical services	(4)(19)
126	Number of unplanned hospital readmission	Clinical services	(7)
127	Number of visits by a physiotherapist prior to hospital discharge	Out-of-hospital	(26)
128	Number of nurses who have completed Advanced Trauma Care for Nurses (ATCN)	Human resources	(31)
129	Measurement and recording of GCS before patient intubation	Clinical services	(7)(11)
130	Performing a surgery to open connective tissue in cases of Acute compartment fasciotomy and in the cases of vascular injuries	Clinical services	(11)
131	The existence of medical guidance system in pre hospital care	Pre-hospital	(61)
132	Performing pre-hospital phase requirements (including vital signs measuring, immobilization, controlling oxygen and fluid, defibrillation and pain management)	Pre-hospital	(11)(12)(19)(50)(56)
133	Performing a CT scan in less than one hour in cases of head injury	Diagnostic services	(11)
134	Obtaining the opinion of at least two surgeons before an injured amputation	Clinical services	(11)
135	Documented nutrition assessment plan after performing surgery	Clinical services	(11)
136	First medical intervention time	Pre-hospital	(50)
137	Oxygen therapy in traumatic patients with multiple injuries	Clinical services	(7)
138	Cervical spine examination and neurological injury protection including collar insertion, radiography, and examining and controlling the consciousness status	Clinical services	(7)
139	Number of patients with multiple trauma transferred to a trauma center without necessary facilities	Clinical services	(7)
140	Determining the status of patients with GCS less than 9 and ISS more than 9 in the least possible time	Clinical services	(7)

WHODAS: World Health Organization Disability Assessment Schedule, GOS: Glasgow Outcome Scale, TRISS: Trauma Injury Severity Score CT: computed tomography, DPL: Diagnostic peritoneal lavage, GCS: Glasgow Coma Scale, ATCN: Advanced Trauma Care for Nurses, ISS: Injury Severity Score, TRISS: Trauma revised injury severity score

Table-2. Separated indicators based on the recommendation of the experts

Primary indicator	Classification	New indicator
The ratio of physicians and full-time emergency assistants to the number of patients	2 indicators	The ratio of full-time emergency physicians to the number of patients The ratio of full-time emergency assistants to the number of patients
The ratio of nurses, patient carriers and service forces to the number of patients in the emergency department (ED)	3 indicators	The ratio of nurses to the number of patients in ED The ratio of patients carrier to the number of patients in the ED The ratio of cleaner forces to the number of patients in the ED
Waiting time to receive the first medical and nursing practices	2 indicators	Waiting time to receive the first medical practices Waiting time to receive the first nursing practices
Waiting time of traumatic patients to go to the surgery room	2 indicators	The waiting time for traumatic patients to go to the surgery room (since the physician order until the discharge from ED) The waiting time for traumatic patients to go to the surgery room (since departure from the ED to the start of the surgery)
The number of RCA and FMEA implementation cases	2 indicators	The number of cases for implementing the RCA The number of cases for implementing the FMEA
The percentage of physicians and nurses working in the emergency department who have received the special training courses related to trauma care and received the valid certificates	2 indicators	The percentage of physicians working in the trauma ED who have completed the advanced trauma life support course (ATLS) and received a valid certificate The percentage of trauma nurses who have completed the advanced trauma care for nurses course (ATCN) and received a valid certificate

RCA Root Case Analysis, FMEA Failure Modes and Effects ATLS Advanced Trauma Life Support, ATCN Advanced Trauma Care for Nurses, ED emergency department

Three indicators of the percentage of Glasgow Coma Scale (GCS) recording or consciousness status in traumatic patients, the ratio of GCS measurements before intubation in traumatic patients, and the ratio of patients' intubation with GCS less than 9 were combined, and the result was considered as the "percentage of GCS recording in traumatic patients".

Six indicators were excluded based on the CVR or CVI score. The indicators of the ratio of temperature measurements in traumatic patients with ESI (Emergency Severity Index) levels 1 to 3 (CVR=0.17), the ratio of non-diagnosed injuries (CVI=0.64), the percentage of antibiotic doses received by patients with open fracture traumatic symptoms (CVR=0.24), the number of disastrous events (CVR=0.26), the percentage of visits by physiotherapists before discharge (CVR=0.24), and the percentage of patients transferred to rehabilitation facilities (CVR=0.24) were excluded.

Five indicators were modified due to having a CVI score of 0.7 to 0.79. The modified form of these indicators is as follows : the ratio of traumatic patients who died to total number of traumatic patients, the satisfaction level of traumatic patients admitted to the emergency department based on the standard questionnaire, the percentage of functional status evaluation of the patient after discharge, the

presence of a protocol and practice based upon it for referral to rehabilitation centers, and the percentage of visits or re-hospitalization in emergency. It should be noted that no indicator was excluded or modified due to the modified kappa score.

In the second phase of the Delphi survey session, held with the presence of 6 experts, individual indicators regarding CVR, CVI, and modified kappa scores were presented to experts, and modifications determined from the views of experts were applied based on the first phase of the Delphi survey. The three indicators of the average time of ambulance presence at incident site, the duration of the pre-hospital phase (from time of contact with the medical emergency center to delivery of the patient to the hospital), and the percentage of patients transferred through the EMS (Emergency Medicine Service) with a stable condition were excluded due to their relevance to the pre-hospital area. . The indicator of percentage of hemoglobin diagnosis test in ESI (Emergency Severity Index) traumatic patients, levels 1, 2, and 3, were excluded due to 100% performance, and the indicators of waiting time for medical, nursing, and counseling services were excluded due to improper recording. Table-3 shows the final 50 indicators based on the CVR, CVI, modified kappa, and relevant areas.

Table-3. Separated indicators based on the recommendation of the experts

Number	Indicators	Indicator Area	CVR	CVI	Modified kappa	Number	Indicators	Indicator Area	CVR	CVI	Modified kappa
1	The average length of stay (traumatic patients)	Outcome	0.8	0.9	0.91	26	The recording percentage of Glasgow Coma Scale (GCS) or the consciousness state of traumatic patients	Clinical services	0.86	0.97	0.96
2	The ratio of traumatic patients to the number of total patients	System management	0.9	0.9	0.9	27	The waiting time for traumatic patients to go to the surgery room (since the physician order until the discharge from emergency department)	Clinical services	0.87	0.93	0.94
3	The presence of a multi-specialized trauma team	Human resource	1	0.9	0.92	28	The waiting time for traumatic patients to go to the surgery room (since departure from the emergency department to the start of the surgery)				
4	The ratio of full-time emergency physicians to the number of patients	Human resource	0.52	0.88	0.85	29	The waiting time for traumatic patients to go to the hospitalization ward	Clinical services	0.8	0.89	0.84
5	The ratio of full-time emergency assistants to the number of patients					30	The existence of a tonometer device for the correct treatment of the compartment syndrome	Clinical services	0.71	0.8	0.8
6	The ratio of nurses to the number of patients in emergency department	Human resource	0.6	0.86	0.85	31	The ratio of presenting the summary of patient records in patients transferred to other hospitals	Clinical services	0.72	0.89	0.87
7	The ratio of patient carriers to the number of patients in the emergency department					32	The average time for receiving diagnostic services (including imaging, tests)	Diagnostic services	0.8	0.88	0.87
8	The ratio of cleaner forces to the number of patients in the emergency department					33	The existence of a trauma registry	System management	0.67	0.89	0.87

9	The percentage of physicians working in the trauma emergency department who have completed the advanced trauma life support course (ATLS) and received a valid certificate	Human resource	0.67	0.91	0.86	34	The number of death-related audits based on the latest version ICD	System management	0.85	0.82	0.83
10	The percentage of trauma nurses who have completed the advanced trauma care for nurses course (ATCN) and received a valid certificate					35	The number of checking the occurring errors	System management	0.82	0.81	0.73
11	The ratio of resources required to manage airway, respiration, circulation and shock (based on the WHO checklist)	Physical space and facilities	0.87	0.93	0.93	36	The number of cases for implementing the RCA	System management	0.46	0.75	0.75
12	The ratio of specific resources for special injuries management (Based on the WHO checklist)	Physical space and facilities	0.72	0.83	0.83	37	The number of cases for implementing the FMEA				
13	Per capita physical space of the emergency department in proportion to the number of patients (daily on average)	Physical space and facilities	0.8	0.9	0.91	38	The number of sessions held to examine the deaths of traumatic victims, and the number of approvals implemented based on it	System management	0.49	0.81	0.72
14	The percentage the traffic accident injured patients transferred through EMS	Clinical services	0.59	0.84	0.84	39	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	System management	0.53	0.84	0.82
15	The percentage of correct triage of patients regarding degree of injury	Clinical services	0.73	0.73	0.89	40	The percentage of patients dispositioned in less than 6 hours	Outcome	0.87	0.95	0.94
16	The percentage of initial measurement of vital signs in traumatic patients	Clinical services	0.8	0.9	0.87	41	The percentage of successful CPR in traumatic patients	Outcome	0.94	0.93	0.94
17	The percentage of correct airway interventions in traumatic patients	Clinical services	0.86	0.88	0.89	42	The mortality rate of traumatic patients	Outcome	0.94	0.95	0.86

18	The percentage of correct measures related to the control of respiratory distress and pneumothorax or hemothorax (air or blood accumulation in the chest) in traumatic patients	Clinical services	0.86	0.78	0.89	43	The length of stay in the intensive care unit (ICU)	Outcome	0.86	0.95	0.94
19	The percentage of intact pulse oximeter used in traumatic patients	Clinical services	0.66	0.88	0.87	44	The number of patients requiring intensive care and transferred to this unit				
20	The percentage of traumatic patients who have received thromboembolic prevention	Clinical services	0.35	0.83	0.79	45	The level of satisfaction of traumatic patients admitted to the emergency department	Outcome	0.4	0.74	0.71
21	The ratio of essential measures (airway nutrition / serum therapy) received by patients with burn injuries	Clinical services	0.86	0.93	0.95	46	The number of the incidence of hospital complications	Outcome	0.38	0.73	0.71
22	The percentage of taking correct measures (circulation and hemorrhage control) taken for traumatic patients (based on patient's age, conditions and previous diseases)	Clinical services	0.93	0.84	0.84	47	The ratio of the died cases among traumatic patients based on injury severity	Outcome	0.67	0.71	0.73
23	The percentage of correct examining of neuromuscular status in four organs in muscular skeletal traumatic patients	Clinical services	0.8	0.8	0.82	48	The percentage of functional status assessment of patients after discharge	Rehabilitation	0.38	0.73	0.71
24	The percentage of correct transfusion (blood and blood and platelet products transfusion) in traumatic patients according to certain degree of shock	Clinical services	0.93	0.84	0.87	49	The existence of a protocol and practice based on it for referral to rehabilitation centers	Rehabilitation	0.38	0.72	0.71
25	The ratio of correct fixation of the fractures	Clinical services	0.8	0.83	0.84	50	The percentage of the visit or re-hospitalization in the emergency department	Rehabilitation	0.45	0.73	0.72

The mentioned score (CVR, CVI, and Modified Kappa) was related to primary indicator (first phase of Delphi survey)

ATLS Advanced Trauma Life Support, *AL* Action Learning, *WHO* World Health Organization, *GCS* Glasgow Coma Scale, *ICD* International Classification of Diseases, *RCA* Root Case Analysis, *FMEA* Failure Modes and Effects, *CPR*: Cardio Pulmonary Resuscitation, *EMS* Emergency Medicine System, *ICU* Intensive Care Unit

Discussion

Trauma management needs fast and well-defined care, adequate resources, pre-hospital and hospital training, and a multidisciplinary and specialized approach. In addition, a well-organized and competent leader is needed for the system to provide appropriate care for patients (17). Trauma care is managed differently around the world, and practices in trauma centers differ throughout the world. The differences in outcomes conceptually have two elements: one is related to population, and the other relates to the quality of service defined by the structure and process (48). Knowledge of the process and organization are important steps in knowing how patient-related outcomes can be optimized. Having knowledge in this area is recommended for a system that focuses on patient outcomes (62). Evaluation is feasible through the definition of indicators. In this study, 50 trauma care indicators related to the hospital setting and facilities in Iran were presented based on four stages and using various methods (comprehensive literature review, expert panel sessions, focus group discussions, semi-structured interviews, and Delphi survey).

The main performance indicators are tools for evaluating the process and outcome and an essential component for the performance improvement program. The variables related to the process and outcome collected systematically and kept in the trauma registry are necessary for performance improvement programs and source data in the audit of trauma care quality (11). Indicators involve the descriptive expression of the examined elements, the person measured, the studied population, the time required for collecting the data, the analytical model for measurement, and a format for the report. The goal of these indicators is to compare real trauma care with the ideal criteria and to diagnose patients requiring more care and receiving less care (50).

The use of these indicators and identifying deviations from indicators provide tools to correct errors and improve performance in the future (4). According to Moylon et al., many management errors in providing services for patients should ultimately lead to improved survival rates of patients through continuous medical training, especially that related to treatment of the cardiovascular system, respiratory system, and primary and better triage of patients with multiple injuries (25). A systematic auditing system generally examines how care standards are observed and provides a

tool for continuing the training of service providers. An effective audit will be evidenced by the low number of preventable deaths associated with trauma (26). Based on a study carried out at Khon Kaen Hospital before and after the implementation of a set of indicators, preventable mortality declined from 2.7% to 2% (5).

A total of 50 indicators for trauma care for Iranian hospitals were identified and presented in the current study. Santana et al. aimed to develop evidence-based indicators for care of injuries in adults and identified 31 indicators in the areas of structure, process, and outcome to evaluate the safety, effectiveness, efficiency, time interval, justice-orientation, and patient-centered care after reviewing the texts and holding four Delphi rounds (50). The indicators were also used in the United States, Australia, Canada, and New Zealand to assess trauma centers. The selection criteria for these indicators included aiming to improve quality, convenience in interpretation, and implementation (50). In other studies, trauma care indicators were identified using qualitative methods and the views of experts. Morrie et al. identified indicators by reviewing texts and relevant documents and through expert consensus; they were collected from 59 trauma centers in the Quebec Traumatic System (4).

The trauma care indicators in this study that were collectible and appropriate to the status of Iranian hospitals were identified based on the literature review and confirmed by experts. Zumsteg emphasized that a localized model can be useful in discovering the defects and improving service processes when used to evaluate the quality of hospital care (62). Quality indicators should meet the national goals but be implemented locally (8). High-income countries use high-level audit filters. For example, they use adequate and trained personnel, advanced diagnostic tools; however, in low- and middle-income countries, this is difficult. If context-related audit filters are used, they will work more successfully (19). While audit indicators have been used in advanced countries for a long-term, their use in low- and middle-income countries is limited. A study conducted in Asian countries revealed that none of them used audit filters. Based on the author's report, the reasons for the lack of audit filters in small hospitals included lack of standard data collection mechanisms, limited resources (for example, the lack of adequate human resources), and the lack of adequate

interaction with local healthcare. The filters should be related to the context, simpler, and more relevant, and support for leaders should also be sought. (19).

Some indicators were excluded based on the panelists' views due to lack of importance, lack of information, incorrect recording of information, lack of human and/or financial resources, non-relevance to the outcomes, and differences among Iranian hospitals in this study. Access to data is crucial in determining standards; information in the registry is used in the development of special indicators (46). Another factor considered by the experts was relevance to outcomes, which has been examined in many studies. Wales et al. found three indicators that were associated with increased mortality: abdominal surgery 24 hours after arrival, treatment of blunt compound tibial fracture 8 hours after arrival, and no fixation of diaphyseal femur fracture. Chest embolism and cranial and abdominal surgery 24 hours after arrival and oral ulcers were also associated with increased hospitalization in intensive care units (ICUs) (14).

In designing indicators, all stakeholders should be considered and resource limitations should be taken into account. Places where the disease burden is high, opportunities exist for improvement, or there are inadequate indicators should also be considered (7). In the opinion of experts, the issues mentioned in the selection of indicators are accompanied by restrictions in developing countries. One indicator should estimate a set of criteria relevant to outcome and reflect what has been accepted with performance. It should include the target population, and the conditions for collecting the indicators should be provided. Those indicators which affect the expected outcomes should be selected. The indicators should examine the expected processes in the study context and reflect the clinical management and clinical practices in progress. They should also identify the population and be collectible. Unfortunately, as noted in this study, file records are often poor sources for data collection, but data that is recorded electronically is easily collected (14).

The most frequent indicators proposed in this study were the service process indicators. Measuring the process directly measures clinical performance. Hospitals with poor performance can focus on outcomes and improve them. In a study that examined the relationship between quality indicators and clinical outcomes using registry data, the results revealed that process measurements could be used to

improve quality, and clinical outcomes could be improved by trying to show the best performance. The outcome measurements can detect the cause, but they cannot detect the root cause. Process measurements are directly prosecuted, because they are related to the guidelines and the best performance (16).

Indicators such as patient mortality, morbidity, and length of stay are beneficial in determining the outcome of care, but the process of care allows for a more comprehensive depiction of the collection of functions that lead to good or poor outcomes (11). One study based on United Kingdom family practice pay-for-performance quality improvement programs estimated that about 40% of the improvement in patient outcomes was related to changes in process performance for five prolonged conditions. Other strong correlations were observed between merged measures of structure and process ($r = 0.72$) and structure and outcome ($r = 0.60$), but a low correlation was seen between process and outcome ($r = 0.20$) in a sample of 600 hospital departments in Sweden (23).

Important outcome measures in this study were mortality and preventable mortality. Mortality has been used as the most common outcome measure in injury research. In fact, studies usually focus on mortality as an outcome in the process of discovering the relationship between indicators and outcomes (62). Preventable mortality (risk-adjusted) is another indicator used to compare trauma centers. Although mortality is an easier indicator to collect and interpret, preventable mortality represents intervening cases that improve health systems (13). In a study by Davtalab Esmaili et al. based on the TRISS scale, 58 deaths were expected among random patients, but 65 deaths occurred (63). Mousazadeh et al. reported that mortality in two traffic injuries groups with high and medium risk was 25.63% and in the low-risk group was 0.42%. The mortality risk was predicted for both severe and moderate risk (more than 50%) and low risk (less than 5%) (64).

Patient evaluation before discharge and the functional status of the patient after discharge were other indicators identified in this study. Patients hospitalized for trauma are rarely stable when discharged, according to studies. Studies have also shown that patients reach a stable condition twelve months after their injury (65–67). Therefore, the patient's functional status needs to be assessed at a time after discharge.

Infrastructures including space, equipment, and facilities were key indicators in this study. Mock et al. assessed the WHO guidelines on minimum facilities for trauma care in the four countries of Mexico, Vietnam, Ghana, and India with surveys in 100 rural and urban sites. The equipment in these countries was relatively adequate; however, there were gaps, especially shortages in airway equipment, chest tubes, and trauma medications, and long waiting times for equipment such as radiography and laparotomy. Service delivery was worse in rural hospitals, and hospitals with a large patient population lacked resuscitation equipment (68).

Other indicators in the study were the presence of trained and specialized personnel and non-medical staff. An ecological study found that readiness of operating room staff was related to lower trauma mortality risk; whereas in some studies, definite time to operating room or emergency laparotomy showed consistent associations with mortality (27). Having a trauma team is one aspect of the trauma system. The trauma team reduces the death rate among trauma victims (69). Data from the Canadian Trauma Center showed that with the involvement of a trauma team for patients with injury severity scores >12, results were significantly better than for other patients (70).

One of the important indicators in this study was the evaluation of patient satisfaction. Murray pointed out the patients' views of quality have been used in various health programs to continuity using care, ensuring effectiveness, and attracting people and other stakeholders involved in healthcare (71). Waiting times for services and patient disposition were the final indicators in this study. In a study on patients' dissatisfaction with emergency physicians, 67% of participants stated waiting time and 19% of them reported the lack of a relationship with the patient as their reasons for dissatisfaction (72). Errors and their causes, complications, and mortality analysis during quality improvement sessions were other important indicators in this study. Based on the evidence, collecting and disseminating evaluation information leads to improved performance (4).

One limitation of the current research was the exclusion of some important indicators due to a lack of information or a lack of facilities. However, given the multi-disciplinary nature of the panels, it was possible to present various indicators during the discussion. Trauma care suffers from a lack of evidence compared to other medical branches, and research into trauma care suffers from low budget issues. In

addition to information regarding the collection, other problems involved include multi-disciplinary, logistic complexities, and inadequate evidence (34).

Conclusions

The increased costs of healthcare and differences in the quality of trauma care services indicated that there is a need to assess the performance of trauma care. In order to perform this assessment, indicators must be used. Using context-related indicators in the area of health services provision appears to be beneficial. In this research, various processes and the ideas of specialists and experts in different fields of medical sciences (related to trauma care) were used to identify local indicators for assessing trauma care, which can be used by policy-makers to assess service quality. They can also be used by developing countries with statuses similar to that of Iran.

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Authors' Contribution

Study design: AJ, HS; literature review: YM; Data collection: Y M, HS, AJ, MP; Data interpreting: HS, YM; Manuscript writing: primary draft was written by YM, and all authors have read and approved the final manuscript.

Conflict of Interests

The authors declared no potential conflict of interests with respect to the research, authorship, and/or publication of this article.

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