European Spine Journal
https://doi.org/10.1007/s00586-023-08010-x

ORIGINAL ARTICLE

Quality of in-hospital care in traumatic spinal column and cord injuries (TSC/SCI) in I.R Iran

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Received: 19 December 2022 / Revised: 10 September 2023 / Accepted: 16 October 2023

Abstract

Purpose This study aimed to implement the Quality of Care (QoC) Assessment Tool from the National Spinal Cord/Column Injury Registry of Iran (NSCIR-IR) to map the current state of in-hospital QoC of individuals with Traumatic Spinal Column and Cord Injuries (TSCCI).

Methods The QoC Assessment Tool, developed from a scoping review of the literature, was implemented in NSCIR-IR. We collected the required data from two primary sources. Questions regarding health system structures and care processes were completed by the registrar nurse reviewing the hospital records. Questions regarding patient outcomes were gathered through patient interviews.

Results We registered 2812 patients with TSCCI over six years from eight referral hospitals in NSCIR-IR. The median length of stay in the general hospital and intensive care unit was four and five days, respectively. During hospitalization 4.2% of patients developed pressure ulcers, 83.5% of patients reported satisfactory pain control and none had symptomatic urinary tract infections. 100%, 80%, and 90% of SCI registration centers had 24/7 access to CT scans, MRI scans, and operating rooms, respectively. Only 18.8% of patients who needed surgery underwent a surgical operation in the first 24 h after admission. In-hospital mortality rate for patients with SCI was 19.3%.

Conclusion Our study showed that the current in-hospital care of our patients with TSCCI is acceptable in terms of pain control, structure and length of stay and poor regarding in-hospital mortality rate and timeliness. We must continue to work on lowering rates of pressure sores, as well as delays in decompression surgery and fatalities.

Keywords Spinal cord injuries · Wounds and injuries · Health facilities · Quality of health care · Length of stay · Patient care

Introduction

In 2015, the World Health Organization (WHO) office in Iran reported 24,896 fatal road traffic crashes (FRTCs) out of a population of 77 million (i.e., 32.3 per 100,000) [1]. Over the same period, the incidence was 10.6 per 100,000 in the USA [2]. The high rate of FRTCs could predispose victims to a higher incidence of spine and spinal cord injuries in Iran than in other settings. The incidence of traumatic spinal cord injury (TSCI) in Iran has been reported as 4.4/10,000 population/year [3]. This value varied from 20.7 to 83.0 million/year in different studies from North America [4]. Differences in highway logistics, public transport availability, safety protection, traffic accident preventive measures and strict law enforcement, speed control and limits, education, traffic congestion, and pedestrian protection contribute to some of these differences in mortality rates. North Americans are also older than Iranians on average, which may explain why falls are more frequent in North America, but traumatic

Extended author information available on the last page of the article

Published online: 24 November 2023

spinal column and cord injuries (TSCCIs) following traffic accidents are less prominent.

The primary goal of each healthcare system review is to assess the quality of care. Therefore, it is imperative for us to know how patients use healthcare facilities following an injury, and whether these facilities are readily accessible. The National Spinal Cord/Column Injury Registry of Iran (NSCIR-IR) was established to allow researchers to access the required data for health system transformation plans. This registry has a suite of processes for registrars and supervisors that enhances data quality control and assurance, thereby improving the validity of the data [5]. Based on a recent scoping review by our team, quality of care concepts in TSCCI had not been summarized in previous literature [6]. Therefore, we designed a review to summarize various quality of care measures in our healthcare system [6]. These concepts were then formulated into indicators (operationalized) and valued through the Delphi method [7]. The result was a comprehensive assessment tool to evaluate QoC in TSCCI [8].

The objective of this study was to utilize the QoC Assessment Tool to map the current state of in-hospital QoC for individuals with TSCCI in Iran. To do this, we evaluated a variety of indicators believed to influence pre- and post-operative outcomes, including 24/7 access to CT scans, MRI, and operating room services, timeliness of decompression, rates of anticoagulant prophylaxis administration, and length of stay. We also investigated in-hospital mortality, as the most important QoC outcome based on the severity and level of spinal cord injury (SCI). Other indicators of patient outcomes included the development of pressure ulcers (PU), urinary tract infections (UTI), and pain .

Methods

Determination of QoC indicators

This study is the final step in the analysis of QoC for TSCCI in Iran. Details of the previous steps are published in a prior scoping review [6], where we retrieved the concepts of QoC from the literature and categorized them into three main categories [6]:

1. Healthcare system structure
2. Medical Process
3. Individuals with TSCI-related outcomes

Each category was further defined by timing (Table 1) and mode of data collection/source (i.e., patient reports obtained from checklists/available national registries/data collections or requests from care centers). We also determined how each category is affected by the six domains of healthcare quality: safe, effective, efficient, timely, equitable, and patient-centered [9]. The Delphi method completed the process of screening and evaluating the indicators [7]. The finalized indicators were classified based on the timeframe categories. To better organize the suggested solutions to improve care in different timeframes, we presented the current state of TSCCI care in the in-hospital phase. To gain a better understanding of these quality-of-care metrics, indicators were classified into three groups (A, B, and C) based on the severity of the spinal injury and management strategies (Table 1).

Table 1 Groups stratification/classification

Classification based on the timeframe
1. Pre-hospital
2. In-hospital
3. Post-hospital
Classification based on the severity
1. Group A: patients with spinal column fracture but no spinal cord injury who were managed non-operatively
2. Group B: patients with spinal column fracture without spinal cord injury who underwent surgery
3. Group C: patients with spinal cord injury

Study population groups

In-hospital QoC indicators were applied differently for the three groups (A, B, and C). For example, timely decompression is not relevant for patients with spinal fractures being managed non-operatively. Health system structure indicators (including 24/7 availability of operating rooms, MRI scanners, and CT scanners) were evaluated independently from injury severity and management strategies. Of note, anticoagulant prophylaxis was added to the NSCIR-IR registry after our recent systematic review of the QoC concept in the current literature and adopting international guidelines for using anticoagulants in SCI management [10]. As we did not gather these data for all registered patients, we chose not to include it in our current analysis.

Study settings and data collection

We applied the QoC Assessment Tool to patients in our NSCIR-IR registry system from 2016 to 2021. The registry contains data from a wide network of 8 trauma centers (referral hospitals). Required data were collected either directly from patients or via the NSCIR-IR database. To assess the quality of in-hospital care (IHC), we collected data to completed response to questions from the QoC Assessment Tool (Table 2). Hospital records were reviewed by NSCIR-IR registrar nurses to obtain metrics regarding health system structures (e.g., availability of 24/7 CT/MRI/

Table 2 In-hospital quality of care assessment tool indicators

QoC indicators for in-hospital care	Results			Benchmarking QoC
Structure				
1. What proportion of spine trauma centers in a catchment area have 24h availability of an operating room for early decompression (<24h)?	90%			Acceptable
2. What proportion of spine trauma centers in a specific area have 24h availability of MRI?	80%			Acceptable
3. What proportion of spine trauma centers in a specific area have 24h availability of CT scan?	100%			Acceptable
Medical process				
4. What proportion of eligible patients undergo early decompression (i.e., <24 h of injury)?	All eligible patients 18.8%	With SCI 22.1%		Below the level of standard
5. What proportion of patients receive evidence-based anticoagulant prophylaxis to prevent thromboembolic events?	N/A			N/A
6. How long is the patient length of stay in the hospital adjusted for the severity of spinal cord injury ASIA Impairment Scale (AIS) in the acute phase of care?	AIS A/B Median (IQR): 10.2 days (17.7)	AIS C/D Median (IQR): 7.9 days (8.9)		No definite criteria for evaluation
7. How long is the patient length of stay in the ICU adjusted for the severity of the spinal cord injury (AIS)?	AIS A/B Median (IQR): 10 days (22)	AIS C/D Median (IQR): 6 days (10.5)		No definite criteria for evaluation
Patient outcome				
8. a: What proportion of patients develop a pressure ulcer (PU) during their first admission? b: What proportion of AIS-A and AIS-B SCI patients develop pressure ulcers during first admission?	All patients 4.2%	SCI All SCI patients 4.2%	AIS A/B 16.2%	8a: No definite criteria for evaluation 8b: Below the level of standard
9. What proportion of patients develops a urinary tract infection (UTI) during their first admission?	0%			No precise check of bacteriuria
10. What proportion of patients is satisfied with pain control measures?	83.5%			Acceptable
11. What is the in-hospital mortality rate of patients?	All patients 3.9	SCI 19.3		Below the level of standard

operating room) and medical processes (e.g., length of stay (LOS) in the hospital and ICU) in each trauma center. Outcomes (e.g., pain, symptomatic UTI) were gathered via patient interviews during admission or after discharge.

Statistical analysis

The data were analyzed, and indicators were calculated by IBM SPSS statistical package (Version 20). Among

Table 3 Demography and outcome of registered patients

	Group A: without SCI and Surgery (*N* = 1348)	Group B: only surgery (*N* = 1008)	Group C: SCI (*N* = 456)	Total	*p* value
Age, mean (SD), year	38.1 (15.3)	37.9 (14.0)	35.1 (13.4)	37.5 (14.6)	0.001
Gender					
Male	947 (70.3)	734 (72.8)	367 (80.5)	2048 (72.8)	< 0.001
Female	401 (29.7)	274 (27.2)	89 (19.5)	764 (27.2)	
Death, N (%)	19 (1.4)	4 (0.4)	88 (19.3)	111 (3.9)	< 0.001
LOS, Median (IQR), days	2.0 (5.0)	5.0 (6.0)	8.0 (12.0)	4.0 (7.0)	< 0.001
ICU LOS, Median (IQR), days	7.0 (8.0)	3.0 (5.0)	9.0 (17.7)	5.0 (10.0)	< 0.001
Pressure Ulcer	29 (2.2)	15 (1.5)	74 (16.2)	118 (4.2)	< 0.001
Urinary infection	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	–
PTE	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	–
Pain					
< 7	1107 (82.1%)	846 (83.9%)	395 (86.6%)	2348 (83.5%)	0.07
≥ 7	241 (17.9%)	162 (16.1%)	61 (13.4%)	464 (16.5%)	
Decompression					
≤ 24			62 (22.1%)	236 (18.8%)	
> 24			218 (77.9%)	1016 (81.2%)	

SCI spinal cord injury, *LOS* length of stay, *ICU* intensive care unit, *PTE* pulmonary thromboembolic

11 indicators, we focused on the in-hospital mortality in patients with SCI as the most important QoC metric. Due to the effect of SCI level and severity on in-hospital mortality (IHM) and pressure ulcers, we performed a stratified analysis by level of SCI (cervical versus thoracolumbar) and severity of SCI (Complete SCI defined as AIS type A & B, Incomplete SCI defined as AIS type C & D).

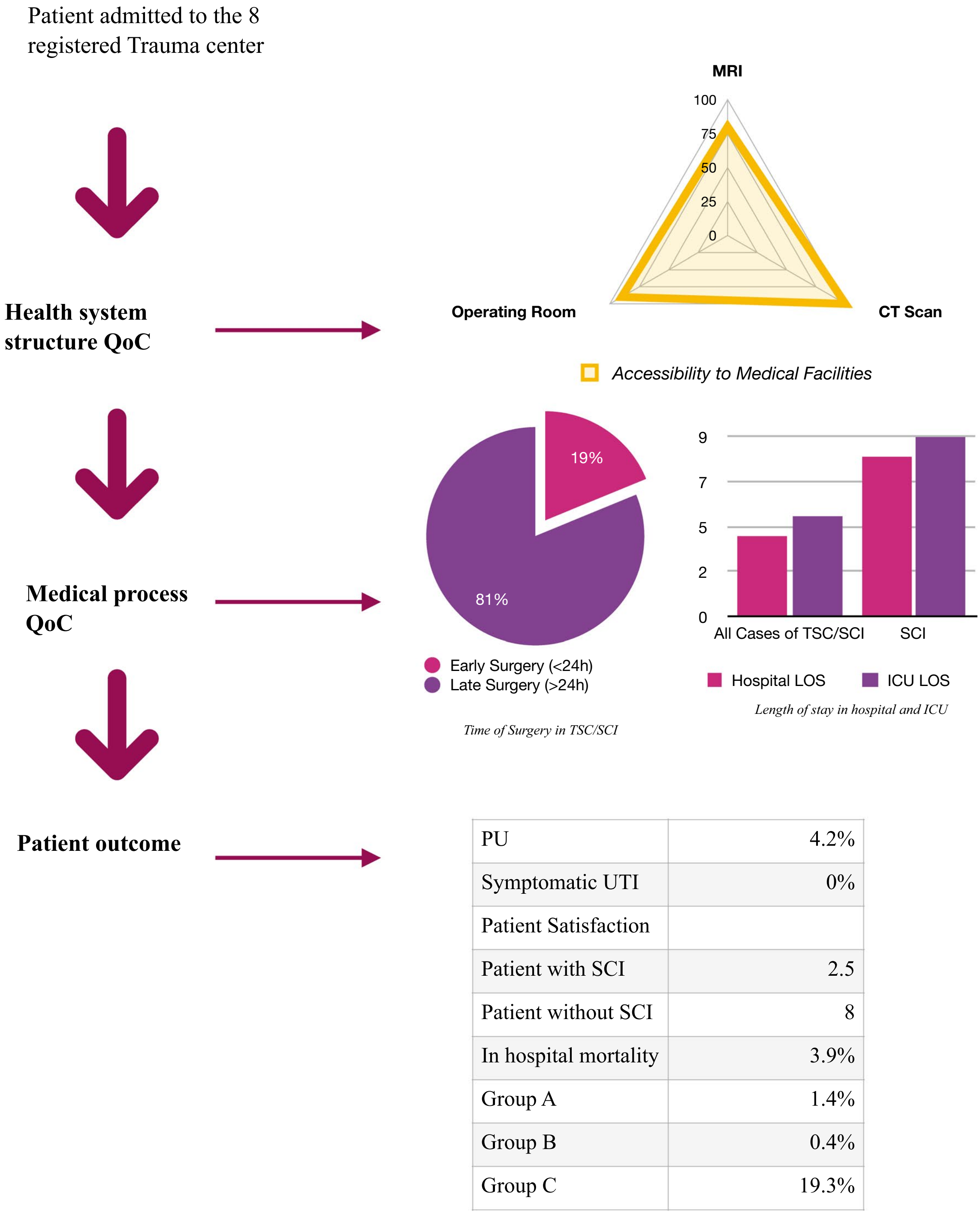
Results

We registered 2812 patients with acute TSCCI during six years of registration (2016–2021) from eight referral hospitals in NSCIR-IR. A majority of registered patients (72%) were male with a mean age of 37.5 (± 14.6) years. The median LOS in the hospital and ICU were four (IQR: 7.0) and five (IQR: 10.0) days, respectively. During hospitalization, 4.2% of patients developed pressure ulcers (PU), and no patients reported a symptomatic UTI. Most patients (83.5%) reported satisfactory pain control (defined as VAS < 7) during hospitalization. All SCI registration centers had 24/7 access to CT scanners. 90% of registration centers had 24/7 access to operating rooms and 80% had 24/7 access to MRI scanners. Only 18.8% of patients who needed surgery (groups B & C) underwent their surgical operation in the first 24 h after admission (Table 3) (Fig. 1).

We had 1348 patients in group A, with a mean age of 38.1 years and a male-to-female ratio of 2.4:1. In group A, the median LOS in the hospital and ICU were two and seven days, respectively. Nineteen (1.4%) patients died in the hospital. Twenty-nine patients (2.2%) developed pressure ulcers during hospitalization. No patients presented with a symptomatic UTI during the same period. Pain control was acceptable in 82.1% of patients.

We had 1008 patients in group B, with a mean age of 37.9 years and a male-to-female ratio of 2.7:1. The median LOS in the hospital and ICU were five and three days, respectively. Four patients (0.4%) died in the hospital. Fifteen patients (1.5%) developed pressure ulcers during hospitalization. No patients presented with a symptomatic UTI during the same period. Pain control was acceptable in 83.9% of patients in this group.

We had 456 patients with SCI (group C) with a mean age of 35.1 years and a male-to-female ratio of 4.1:1. Although early decompression was an important QoC indicator in this group, only 22.1% of patients with SCI underwent decompressive surgery within the first 24 h after admission. The median LOS in the hospital and ICU were significantly higher than the other groups at eight and nine days, respectively (p value < 0.001). Subgroup analysis of LOS based on neurological impairment revealed LOS was significantly longer in patients with complete neurological deficit (AIS A & B) than in patients with an incomplete injury (AIS C & D) (p value: hospital LOS: 0.009; ICU LOS: 0.02). Eighty-eight patients (19.3%) with SCI died in hospital, which was significantly higher than that of other groups (p value < 0.001). The incidence of PU was also significantly higher in the SCI group (16.2% versus 2.2% in group A and 1.5% in group B, p value < 0.001). Additionally, a statistically higher rate (19.4%) of in-hospital PU was observed in patients with



PU	4.2%
Symptomatic UTI	0%
Patient Satisfaction	
Patient with SCI	2.5
Patient without SCI	8
In hospital mortality	3.9%
Group A	1.4%
Group B	0.4%
Group C	19.3%

Fig. 1 In-hospital quality of care indicators

complete motor (AIS A and B) SCI than in patients with an incomplete motor injury (p-value: 0.05). Even though the injury severity was higher in group C, pain control was not significantly different between groups (Table 4).

The IHM rates were 1.4% in group A, 0.4% in group B and 19.3% in patients with SCI. Stratified analysis of IHM in patients with SCI revealed that the severity of SCI had a greater effect on the IHM than the level of injury. Patients with complete thoracolumbar (TL) SCI had a three times higher mortality rate than patients with incomplete Cervical (C)-SCI (17.5% versus 5.7%); however, IHM in patients with complete C-SCI was 33.5% in the acute setting, which was nearly double the mortality rate of patients with complete TL-SCI (Table 5).

Table 4 Subgroup analysis of hospital and ICU LOS and pressure ulcer regarding severity of neurological injury

	AIS A&B ($N=227$)	AIS C&D ($N=179$)	p value
LOS, median (IQR), day	10.2 (17.7)	7.9 (8.9)	0.009
ICU LOS, median (IQR), day	10.0 (22.0)	6.0 (10.5)	0.02
Pressure Ulcer	44 (19.4)	23 (12.8)	0.05

Table 5 Age and sex adjusted In-hospital mortality rate in SCI

	Standardized mortality rate (%)
Incomplete thoracic or lumbar	0.77
Incomplete cervical	5.7
Complete thoracic or lumbar	17.5
Complete cervical	33.5

Discussion

In this study, we present the quality of current in-hospital care for TSCCI in Iran by evaluating 2812 patients who suffered acute TSCCI and were registered in NSCIR-IR within the past six years. Most of our cases (more than 70%) were male patients with a mean age of 37.5. In concordance with our results, multiple studies [11–13] found higher rates of TSCCI in men (male to female ratio was about 3:1). Of note the mean age of our study cohort was younger than that of other studies by 40 years or more.

Pressure ulcers are a major complication following TSCCI that may occur acutely or during the rehabilitation phase. Incidence rates of pressure ulcers can range from 2.7 to 54%, depending on the level of spinal injury. PU frequently prolongs the length of stay, which can increase care costs and worsen mortality [14]. The total incidence of PU in our study was 4.2% (up to 16.2% in patients who had SCI), which may be considered acceptable when compared to incidence rates of other developing countries, some of which report a PU incidence as high as 47% [15–17]. Using the same NSCIR-IR data source, Farahbakhsh et al., estimated PU rate to be 3.1% and identified treatment center, marital status, having a SCI, and number of days in the ICU to be significant predictors of PU [18]. The increase in incidence by 1.1% seen in our study could be explained by the increase in included participants relative to Farahbakhsh et al. study. In the eight referral centers, constant repositioning and the use of pressure-relieving tools, including specialized mattresses, cushions, and pads, were some evidence-based practices that were seen to reduce PU in TSCCI patients. These practices contributed to the lower incidence of PU in our study population. Future efforts should instead emphasize advanced wound care methods to guarantee better skincare and promote smart care beds and cushions with automatically adjustable features to redistribute pressure and prevent extended skin stress and eventual ulcers. Moreover, patients who experience malnutrition, particularly those who do not receive adequate nutritional support during their prolonged stay in the intensive care unit, are at a heightened risk for developing PU. Individuals with multiple traumas, particularly those with traumatic brain injury (TBI) who are in a coma, are also at an increased risk for PU. However, the presence of a care provider or nurse, often through marriage or a dedicated caregiver, has been associated with a lower risk of developing PU. Furthermore, the data suggest that higher levels of education serve as a preventive factor for PU [19]. Therefore, measures to prevent PU should include the provision of a care provider or nurse, as well as ensuring adequate nutritional support and emphasizing the importance of education in reducing the risk of PU.

UTIs are another complication associated with TSCCI that should be evaluated in all patients. Interestingly, we found no reports of symptomatic UTI in our cases during hospitalization, though incidence rates are reported to be 1.1% in both developed and developing countries [20, 21]. This may be due to incomplete data registration of patients' complications or subsidence of UTI symptoms by analgesia. A recapture study can be done in the future to further investigate the incidence of UTI in this population. Another possible explanation for our results would be the high rate of antibiotic prophylaxis in TSCCI patients, which is not well documented in the NSCIR-IR. This lack of documentation makes it difficult to confidently analyze the true incidence of UTI in our cohort. Despite these findings, it is nevertheless important to take necessary precautions in order to minimize risk of UTIs. It is crucial to ensure proper catheter care with a strict aseptic technique during catheterization. Due to increased risk of UTIs associated with prolonged indwelling catheterization, use of clean or sterile intermittent catheterization is highly recommended. Patients should be educated about bladder training, the importance of adequate hydration, and personal hygiene in order to minimize risks of developing a UTI. Additionally, regular post-operative check-ups are essential to early detection and treatment of UTIs. Further studies are needed to assess the efficacy of these methods at reducing UTIs in TSCCI patients, and to determine whether any other prevention strategies should be implemented.

Many SCI patients suffer from different types of pain, including neuropathic pain, which may negatively influence their quality of life. According to two publications [22, 23], up to 80% of these patients complain about some type of pain following their injuries. Our results showed a 16.5% in-hospital rate of severe pain (VAS score equal to or more than seven), which is suggestive of acceptable pain control during hospitalization [24, 25].

IHM following TSCCI can be influenced by several factors including age, the severity of the trauma, AIS grading, and patient's comorbidities [11, 26–29]. Although IHM rates are generally below 10% [27–35], some studies have suggested rates as high as ≥ 20% [36, 37], especially in older patients [35], and those from developing countries [37, 38]. While The IHM rate in the present study was 19.3% among the patients with SCI (group C), the rate was 33.5% in complete cervical cases, which is significantly higher than the reported mortality rate of 20.66% for complete (AIS A) acute subaxial cervical SCI in 21 studies conducted worldwide [39]. In addition, the in-hospital mortality rate for complete thoracolumbar SCI was 17.5%, and for However, when compared to a study by Azarhomayoun et al. (2018), which included 11,205 patients with traumatic thoracolumbar SCI from 24 studies worldwide, the reported in-hospital mortality rate was 5.2%. [40] The high in-hospital mortality rates observed in the provided data suggest that the QoC in our SCI patients is below standard. The elevated mortality rates indicate that there may be challenges or deficiencies in the healthcare system or the delivery of care in this population. Identifying the factors contributing to these high mortality rates is essential in order to address any gaps in care and improve patient outcomes.

Studies from North America have identified various predictors of hospital deaths following TSCI [26, 27, 30]. Among these predictors, old age, comorbidities, level of injury, and severity of injury are all associated with a higher probability of death during initial hospitalization after acute TSCI. Furthermore, poor access to medical facilities and delayed decompressive surgery are other factors that contribute to the high IHM in developing countries [37, 38].

A stratified analysis in the present study revealed that IHM was heavily influenced by SCI severity, and not by level of SCI. These findings are consistent with associations reported in prior studies [26, 27, 30]. Previous data have shown that cervical injury, AIS score ≥ 4, and complete TSCI result in a higher probability of mortality [27]. Similarly, our data showed a higher rate of IHM with complete TL-SCI and complete C-SCI than incomplete TL-SCI and incomplete C-SCI.

Moghaddamjou and Fehlings suggested that the evidence for early (< 24 h) surgical decompression (ESD) is mixed [41]. Additionally, a meta-analysis showed that although early spinal surgery was significantly associated with improved neurological and LOS outcomes, the evidence supporting early spinal surgery after TSCI lacks robustness as a result of different sources of heterogeneity within and between original studies [42]. However, ESD has been associated with significantly improved neurological outcomes [43] and is therefore highly recommended [44–47]. The findings of Wengel et al. [48] suggest that patients with complete cervical TSCI have more significant clinical improvement after ESD than those with incomplete cervical TSCI. However, they observed no significant effect of ESD in patients with thoracic and thoracolumbar TSCI [49, 50]. In contrast, two studies [51, 52] observed a significant improvement in the mean motor scores in patients with incomplete thoracolumbar TSCI after ESD but no motor improvement was noted in patients with complete thoracolumbar TSCI. A recent meta-analysis by Chanbour et al. showed a significantly shorter mean time from injury to OR in HICs (1.92 days, 95% CI 1.44–2.41) compared with LMICs (3.27 days, 95% CI 2.27–4.27; $p = 0.020$) [53]. Our results showed that only 18.8–22.1% of patients who needed surgery underwent surgical decompression (SD) within the first 24 h post-SCI, which shows our median time from injury to OR is even worse than LMIC. Higher mean time from injury to OR may be due to infrastructural limitations or inadequate healthcare facilities in LMIC or developing countries. According to our data, inadequate coordination between trauma center and EMS personnel, excessive preoperative procedures such as tests and paperwork, and lack of clear criteria for prioritizing urgent cases were identified as a few key reasons for delayed surgery.

The low rate of early surgery in our centers relative to the standard of care highlights the need for a comprehensive review of the current trauma system. Findings from a previous study in the setting of NSCIR-IR revealed a concerning delay in the patient care process following SCI. From the onset of injury, it takes approximately 19 h until the first admission, indicating significant time lags in several stages of the process. These stages include the time from injury to the emergency call, the response time of emergency services to reach the patient, the duration of on-site management, the transit to the first care center, and finally the transfer to the final care center. Furthermore, there is a substantial delay of almost five days from the time of injury until surgical decompression is performed. Overall the median time from injury to decompression was 6.5 days in that study [5]. SohrabiAsl et al. examined reasons for delaying decompression surgery in NSCIR-IR registry centers in a qualitative study by interviewing 12 Iranian neurosurgeons, and found that operating times were most heavily influenced by the patient's condition upon arrival to the hospital, as well as surgeons' wrong attitude. Other reasons include delays transferring the patient from the field to the trauma center and difficulties preparing the necessary equipment needed for surgery. Time to surgery was not substantially influenced by surgeon attitudes or a lack of knowledge on current surgical guidelines for the management of TSCI [54]. In order to shorten the delays for decompression surgery, we must first see what strategies have been used by countries who are more successful at managing patients with multiple traumas. At this time, there is still some debate as to which strategies should be borrowed from hospital systems of other countries in order to maximize patient outcomes in Iran [55, 56]. Potential solutions include; (1) Improving communication between trauma center surgeons and EMS personnel; (2) Simplifying and streamlining pre-operative procedures, lab tests, and consent forms to ensure that patients are prepared for surgery without needless delays; (3) Ensuring that there are enough qualified surgeons and support staff available to perform surgeries; (4) Establishing clear criteria for prioritizing urgent cases, such as TSCI patients, in need of emergent surgical decompression; (5) Establishing a system that tracks delays in surgery and identifies common bottlenecks that can be addressed to better optimize efficiency in the hospital and operating rooms (6) Adopting technical tools such as surgical scheduling software, digital imaging, and electronic health records (EHRs) to increase coordination, reduce paperwork, and promote communication in order to streamline patient care. In this regard we have recently adopted guidelines to ensure timely decompression surgery in SCI patients in Iran [57], Different studies have also described the utility of different surgical timing and approaches, (prone or supine) [58–61] as well as alternative methods of surgery for stabilization (e.g., percutaneous pedicle screw fixation) [62]. Finally, the need to communicate to patients in a timely manner and the efficient transfer of surgical equipment within hospitals are other improvements that have been proposed in previous studies [48–51].

We observed shorter lengths of ICU and hospital stay in patients who underwent surgery and in patients with AIS-C&D, which presents a potential confounding effect of AIS score on LOS. In other words, patients with less severe neurological injuries became ambulatory sooner than patients with complete SCI, which resulted in a shorter ICU and hospital LOS. It is worth noting that the length of ICU stay and the length of hospital stay were 6–10 and 7.9–10.2 days, respectively, and are lower than findings by Gedde et al. [63] (3.4 weeks) and Zhang et al. [64] (113.5 days). In all of the discussed groups (A, B, C), LOS in the ICU was longer than the hospital LOS. The hospital LOS was calculated from all registered patients in the study, ranging from one to 373 days. ICU LOS was calculated from 627 patients admitted to the ICU during hospitalization, which implies more severe injury and worse general condition compared to the general hospital group.

Iran is a developing country with an estimated population of 85 million. It shares common limitations with other developing countries or LMICs with regard to healthcare system infrastructure. Limited resources in developing countries lead to challenges in delivering healthcare services, particularly in rural and remote areas. High disease burden and inadequate access to care are common barriers in developing countries that significantly impact the healthcare systems. In addition, weak health information systems make it difficult to collect and analyze data on disease prevalence, health outcomes, and resource allocation, hindrances that prevent effective planning, monitoring, and evaluation of healthcare programs in these regions. In this study, we implemented the QoC assessment tool in NSCIR-IR to map the current state of in-hospital QoC of individuals with TSCCI in Iran. We believe the findings of this research may also help to map the in-hospital QoC of other developing countries.

Limitation

This study is not without limitations. We did not include data on anticoagulant prophylaxis in the NSCIR-IR and therefore did not use this metric in our analysis. Another limitation was that we could not find an agreed upon minimum clinically acceptable value for the presented indicators. This makes it difficult to compare our healthcare systems with those of other regions. Also, although three indicators including median cost of healthcare services in the year following SCI, acute hospital charges, rehabilitation care costs were considered, our expert panel did not select these indicators as part of this study. Our study is also limited with regard to the cost of treating the complications and LOS. We hope that by implementing this checklist in different health systems, we can find the acceptable clinical value for each indicator for future comparisons.

Conclusion

Our study showed that the current IHC of our patients with TSCCI is acceptable in structure, pain control, and length of ICU stay and below standard regarding in-hospital mortality rates and timeliness of care. Despite a relatively low rate of PU among our patients, increased education and quality of hospital care may decrease PU rates even further. A more thorough investigation at the level of local hospitals can help to identify the factors that affect the timely management and treatment of TSCCI. Patients in need of urgent operative management did not often receive surgery in a timely manner and experienced high rates of mortality as a result. In this context, it is necessary to plan effective strategies and actions, both inside and outside of the hospital, to minimize delays to the operating room. Successful implementation of these strategies may necessitate working together with a wide range of regulatory entities and stakeholders of the healthcare system (for example deputy of treatment in the Ministry of Health, insurance system, pre-hospital emergency system, and scientific associations of neurosurgeons).

In conclusion, our study has shown that indicators for surgical outcomes are highly dependent on the data quality and extent of NSCIR-IR. We should not rely solely on them. Rather, conducting similar studies from trauma centers outside the NSCIR-IR using the QoC Assessment Tool can better complete the map of the state of TSCCI care quality in the entire country.

Appendix 1: Alex R. Vaccaro conflict of interest-health care entity relationships and investments

Entity	Relationship (see legend below)	Value
Replication medica	d	
Medtronics	c	
Stryker spine	c,	
Globus	c,d	
Paradigm spine	d	
Stout medical	d	
Progressive spinal technologies	d	
Advanced spinal intellectual properties	d	
Aesculap	c	
Spine medica	d	
Computational biodynamics	d	
Spinology	d	
Flagship surgical	d	
Cytonics	d	
Bonovo orthopaedics	d	
Electrocore	d	
Insight therapeutics	d	
Flowpharma	d	
Rothman Institute and related properties	d	
AO spine	g	
Innovative surgical design	d	
Orthobullets	d	
Thieme	c	
Jaypee	c	
Elseviere	c	
Taylor francis/hodder and stoughton	c	
Expert testimony	g	
Vertiflex	d	
Avaz surgical	d	
Dimension orthotics, LLC	d	
Spine wave	c	
Atlas spine	c	
Nuvasive	d	
Parvizi surgical innovation	d	
Franklin bioscience	d	
Deep health	d	

Legend: a. Consulting / Independent Contractor, b. Service on Scientific Advisory Board / Board of Directors / Service on Committees, c. Receipt of Royalty Payments, d. Stock / Stock Option Ownership Interests, e. Institutional / Educational Grant, f. Deputy editor/ Editor/ Editorial Board, g. Member in good standing// Independent Contractor

Acknowledgements The research reported in this publication was supported by Elite Researcher Grant Committee under Award Number [972056] from the National Institutes for Medical Research Development (NIMAD), Tehran, Iran. Also, Sina Trauma and Surgery Research Center, Tehran University of Medical Sciences [Grant Numbers: 98-3-93-45593 and 1401-3-93-62693] and Tehran University of Medical Sciences [Grant Number: 98-01-38-41516] funded this work. We acknowledge the Deputy of Research and Technology, Ministry of Health and Medical Education of Iran support for the NSCIR-IR.

Declarations

Conflict of interest None declared except Alexander R Vaccaro (attached as Appendix 1).

Ethical approval The Ethics Committee of National Institute for Medical Research Development Islamic Republic of Iran (NIMAD) approved the study. The reference number is IR-NIMAD-REC-1397.519. In addition, the Ethics Committee of Tehran University of Medical Sciences approved the study [Reference Number: IR.TUMS.VCR.REC.1398.332] and the NSCIR-IR with approval ID of IR.TUMS.MEDICINE.REC.1401.133.

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