ივანე ჯავახიშვილის სახელობის თბილისის სახელმწიფო
უნივერსიტეტი

მედიცინის ფაკულტეტი

დოქტორანტურის საგანმანათლებლო პროგრამა
„საზოგადოებრივი ჯანდაცვა და ეპიდემიოლოგია“

ეკა ბურკაძე

თავის ტვინის ტრავმული დაზიანების ეპიდემიოლოგიური მახასიათებლების შესწავლა თბილისის ორი ჰოსპიტლის მაგალითზე და ჯანდაცვის რესურსების შეფასება

ავტორეფერატი

სამეცნიერო ხელმძღვანელი: ნინო ჩიხლაძე

საზოგადოებრივი ჯანდაცვის დოქტორი, პროფესორი

თბილისი, 2021 წელი

The epidemiological characteristics of traumatic brain injury on the example of two hospitals in Tbilisi and evaluation of healthcare resources

Introduction

Traumatic brain injury (TBI) is an important public health and socio-economic problem worldwide, disproportionally affecting low- and middle-income countries (LMICs) where the 85% of global population reside. TBI is a dominant cause of mortality, particularly among young adults, as well as a leading cause of permanent disability among survivors. According to the World Health Organization (WHO), TBI will become the third leading cause of mortality amongst all age groups by the year 2020.

TBI is often called a "silent epidemic" because its consequences can be long-lasting and are often not immediately apparent. Mild TBI and the cumulative impact of repetitive TBI, such as from some contact sports, are difficult to diagnose, also contributing to the silent nature of the TBI burden. At all levels of severity, TBI can cause temporary or permanent disability that is difficult to quantify at the individual, familial, or societal level. Despite the challenges of quantifying the incidence and burden of TBI, it is clear that this condition impacts productivity and self-reliance, places a heavy burden on caregivers, and has enormous social cost.

Emerging economies such as Georgia provide opportunities to integrate TBI prevention and treatment improvements as the health economy grows. From 1921 to 1995, the Georgian healthcare system was based on the Soviet Semashko model, and Georgian health authorities had very little input or control. With increased sovereignty in 1995 a new social insurance system and increased local control of healthcare delivery was

established with assistance from the World Bank, World Health Organization (WHO), United Nations Children's Fund (UNICEF), and American International Health Alliance (AIHA). From 2007 to 2012 the Georgian health care system became more decentralized and privatized, and in 2013, the government introduced a Universal Healthcare Coverage System that covers the entire country.

Reducing the long-term consequences of TBI requires timely and organized care. To formulate a societal-level strategy for effective prevention and treatment, it is essential to understand current systems and to build evidence-based strategies using clinical data. However, in many developing countries, the reduction of TBI burden has been hindered by a lack of coordinated care and data on effective TBI prevention and treatment options.

The majority of TBI research comes from high-income countries, especially in Western Europe and North America, and much of the research is possible due to the presence of trauma registries. Despite high and growing rates of TBI in LMICs, there are many critical gaps in knowledge of TBI that need to be addressed. Lack of good quality data on TBI is a disruptive factor in estimating the true burden and magnitude of TBI as well as in identifying possible modifiable risk factors associated with injury occurrence.

Georgia, an emerging economy with a high rate of traumatic brain injuries, has no national or hospital-based trauma registries. Lack of data is one reason that no studies have been published to describe trends and characteristics of TBI-related hospitalizations.

This study aimed to establish the registries and assess causes and outcomes in TBI patients presenting to two major trauma hospitals in the capital city - Tbilisi and to assess the health resources involved in the management process of TBI. The main objectives of the study were: to study the general trends of hospitalization of patients with traumatic brain injury in the country; to identify current TBI prevention and treatment capacity: description of all cases of hospitalization with traumatic brain injury on the example of two hospitals; to study the associations between the severity of traumatic brain injury and other demographic and injury characteristics.

The data reported here were collected as a part of the project INITIatE: International Collaboration to Increase Traumatic Brain Injury Surveillance in Europe, funded by the United States National Institutes of Health and led by the University of Iowa and the Cluj School of Public Health (NIH/NINDS R21NS098850).

This mixed-method project collected information using country-based healthcare data and key informant interviews to describe TBI national leadership and treatment capacity at the pre-hospital, acute care, and rehabilitation phases. County-based healthcare data was pulled in 2017 and key informant interviews were conducted in 2018.

Ethical approval

Ethical clearance for conducting this study was secured by the Georgian National Centre for Disease Control and Public Health Institutional Review Board (IRB #2018-002 11.01.2018) in compliance with Georgian legislation and international bioethical framework.

Hospital Selection

Study hospitals were identified based on a national patient census and included hospitals with the highest number of TBI admissions in 2017. All trauma hospitals were located in the capital city of Tbilisi. In 2017, hospitalizations in Tbilisi numbered 3441, and 10 hospitals accounted for 80% (2785 patients) of admissions. These hospitals were selected for participation. Hospitals were categorized into levels of trauma-care capacity according to the classification system of the American Trauma Society. Eight were categorized as level 1 trauma centers and two were classified as level 2.

Survey Development

A semi-structured survey was designed to cover various aspects of TBI care with questions pulled from previous literature and from consultation with the project Board of Advisors, which included anesthesiologists, emergency department physicians, epidemiologists, neurologists, and neurosurgeons. Interview questions addressed pre-hospital care, in-hospital care, rehabilitation care, hospital and country-level guidelines and protocols for treatment, data collection practices, and the government agencies and professional organizations leading TBI prevention and care. The survey was translated into the Georgian language and terminology was reviewed by the field specialists, who provided feedback on the initial formulation of questions.

Data Collection

At each hospital, the key physician identified by the hospital administration as being the lead in TBI care was interviewed. Individuals included two neurosurgeons, one neurologist, three anesthesiologists, and four emergency physicians. Each of the ten respondents agreed to complete the survey with audiotaping, and gave verbal consent for the interview. Participants were read the survey questions and answers were recorded.

Analysis

Quantitative and open-ended responses to survey questions were collected through notes taken during the interview and transcriptions of audio recordings. Open-ended questions were coded to identify separate themes, and themes were reviewed to identify common responses. Coding was conducted by hand and validated through multiple entry.

Results

Pre-hospital Care

Participants were asked to identify if the country or region has a pre-hospital trauma system that provides standardized triage and transport of patients based on their clinical needs. Participants were then asked to describe the process used for patient transport to emergency hospitals. All participants responded that Georgia has no pre-hospital trauma system. Pre-hospital triage and mobilization of emergency services are provided by an Emergency Response Center, which is accessed by the public using the country-wide number "112." The Emergency Response Center perform initial triage and mobilize field care services. This model is

similar to the U.S. model of emergency management and is in contrast to the European model in which hospitals provide response teams.

Decisions about transport to trauma hospitals are not based on severity of injury or clinical need of the patient. Every hospital with emergency services, both private and state-owned, is obliged to have written agreements with emergency ambulance services. Ambulances transport patients based on which hospital they have agreements with and in coordination with the Emergency Response System which will identify the nearest hospital the ambulance service work with.

TBI patients most commonly arrive at hospitals by ambulance. A few arrive by private vehicles and, in rare cases, by a helicopter operated by the Ministry of Internally Displaced Person from the occupied territories, Labor, Health and Social Affairs of Georgia (MOH). All participants reported that patient transfers seldom occur between trauma hospitals because they all provide trauma services; when they do occur it is because of insurance issues. However, it is common for patients to be transferred from rural areas and smaller towns to Tbilisi, in particular from basic-care medical facilities, to specialized-care facilities.

When asked about protocols to ensure that patients receive appropriate triage, field care, and transport, all respondents stated that there are no standardized protocols. Hospital personnel, including specialists such as neurosurgeons, reported that they are not consulted about which hospital patients are transported to.

Acute Care

Responses regarding existing frameworks for treatment and care of TBI patients were varied, with 50% of interviewees responding that existing

frameworks for treatment and care are based on international requirements and guidelines; 30% that existing frameworks are based on national requirements and that patients are generally assessed and treated by neurosurgeons; and 20% stated that no frameworks exist and hospitals use their own guidelines. All participants indicated that the majority of TBI patients are admitted to hospital through the emergency department.

All of the participating hospitals provide care for TBI patients 24 hours a day and seven days a week. Among the eight adult hospitals, six (75%) had neurologists and 7 (87.5%) had neurosurgeons in-house at all times. Of the two children's hospitals, both had neurologists in-house at all times and one had neurosurgeons in-house at all times. Radiologists were available in-house for all hospitals, while ear/nose/throat specialists were on-call for seven (87,5%) of adult and one (50%) of children's hospitals. Computed Tomography Scanning (CT) was available in all 10 hospitals, whereas Magnetic Resonance Imaging (MRI) was available only in three of them.

Rehabilitation

Rehabilitation services represent an important gap in TBI care in Georgia. The majority of respondents (90%) indicated that rehabilitation services were available only in some clinics and not in the interviewees' hospitals. The one respondent (10%) whose clinic had rehabilitation services noted that the services are limited to physiotherapy with little opportunity for cognitive therapy. Two participants (20%) noted that neither the government or private insurance finances rehabilitation services, and two participants (20%) also stated that the quality and financial availability of rehabilitation services are serious problems. All participants mentioned that access to rehabilitation services was limited for all people, but that

TBI patients who live outside of the capitol city have almost no access to services.

Gaps in TBI Prevention and Care

The most pressing gaps identified for TBI care were related to pre-hospital care, rehabilitation care, and infrastructure for providing in-hospital care. Access to specialists and quality of care by specialists were not identified as a gap. Reasons for deficiencies in care for TBI patients included: a lack of access to current evidence through access to medical journals or international decision-making committees; a lack of medical equipment for diagnosis (such as CT scan availability); a lack of financial resources; and lack of rehabilitation services.

Participants were also asked to identify gaps in prevention. Participants identified lack of priority of safety in relation to road traffic and workplace safety; lack of country-level policies requiring use of safety equipment such as helmets; and lack of a safety culture to promote safe behaviors.

National Leadership for TBI Treatment and Prevention

Responses regarding which national agency is responsible for leadership in TBI treatment were inconsistent. The Ministry of Internally Displaced Person from the Occupied territories, Labour, Health and Social Affairs of Georgia (MOH) was identified as the lead country agency by six (60%) of respondents, the Georgia Neurosurgery Society by two (20%), and the Shota Rustaveli National Science Foundation by 2 (20%). The Georgia Neurosurgical Society was identified by most respondents as the lead

professional organization for physicians who treat TBI, but only 20% of respondents reported being members. All interviewees stated that no existing policies or legal frameworks at the national level regulate the treatment and care of TBI patients, and that none of the agencies identified as the country lead in TBI convened physicians to discuss treatment protocols or advocated for prevention strategies.

The data reported here were collected as a part of the project INITIatE: International Collaboration to Increase Traumatic Brain Injury Surveillance in Europe, funded by the United States National Institutes of Health and led by the University of Iowa and the Cluj School of Public Health (NIH/NINDS R21NS098850). We conducted a prospective observational study from March, 1 to August, 31, 2019 within two high-volume trauma hospitals. The two hospitals were selected because they have the highest trauma patient volume; one serves adults and has 320 beds (Academician O. Gudushauri National Medical Center) and the second is a pediatric hospital with 266 hospital beds (M. Iashvili Children's Central Hospital). Both hospitals are located in the capital city of Tbilisi (population 1175 200) and serve the country (population 3716 900) in providing Level I trauma care. All patients admitted to one of the study hospitals with a TBI diagnosis (ICD 10 codes: S06) were eligible for participation. Trained research personnel identified admitted patients that met study criteria and then collected information through medical record review and discussion with the treating medical team. The researchers did not interact with the patient directly; any communication with the patient was conducted by the medical team for the purposes of completing the medical record. This project was approved by the Georgian National Centre for Disease Control and Public Health Institutional Review Board.

The TBI registry variables and codebook were developed through a participatory and iterative process. First, sample registries were identified using a literature search and by contacting investigators with funded TBI registry projects (funded through NIH and the EU). A set of core variables and a codebook were developed with expert opinion input and the study team, and once finalized the registry was pilot tested using medical records in each of the hospitals. Medical records were insufficient in providing the detail needed to complete the registry information, so a prospective registry design was established.

The study variables included: demographics (age, gender, employment and social role), mechanism and intent of injury, type of admission, admission GCS, diagnostics, management and treatment (I e length of hospital stay, discharge GCS and mortality).TBI severity was measured using the Glasgow Coma Scale (GCS) scores at admission, and the patients were categorized into three groups: mild (13–15), moderate (9–12), and severe (3–8).

Data was collected on paper forms and uploaded into a REDCap electronic database, a secure web application used for developing and managing surveys and databases. Monthly data quality checks were conducted to ensure high-quality data collection. Once entered, cleaned, and quality checked, the final database was exported to SPSS for analysis. TBI-related variables were examined using descriptive statistics. Demographic and injury characteristics were examined in relation to the outcomes of hospital length of stay and status (discharged home, discharged to rehabilitation, died, and unknown). Place of occurrence was examined with respect to age categories. Clinical features including TBI severity, CT scan results, injury diagnoses, and procedures including surgery,

ventilation, and medication were examined by hospital length of stay and discharge status, which were outcome measures used to indicate severity. Differences in categorical variables were tested with chi-square tests of independence.

Results

Patient characteristics

During the period under study, a total of 542 TBI-related hospitalizations were studied, of which 63% (n=341) were male and 37% (n=201) were female, giving a male to female ratio of 1.7:1. The age of patients ranged from 1 month to 94 years. The average age was 17.7 and the median age was 11.1, which is reflective more of our sample of one pediatric and one adult hospital than the population distribution of TBI. The modal age group was 0–14 accounting for 337 (62%) patients, followed by 15–24 years accounting for 77 (14%) patients. In accordance with the age distribution, 247 (45%) of the hospitalized patients were students, and the next most common social role was unemployed, accounting for 115 (21%) patients.

Most of the patients (n=483, 89%) sustained an injury in an urban area and the top place of TBI occurrence was at home (n=175, 32%). Most of the TBI hospitalizations (n=514, 95%) were due to unintentional injuries, and only 2% (n=9) of patients suffered from work-related injuries. Among all age groups, the predominant mechanism of injury was falls (58%) mostly (60%) occurring among males. Struck by or against object was the second most common cause after falls with 22%, followed by road traffic injuries at 15% (n=82). Most road traffic injuries (n=22, 68%) occurred

among vehicle passengers followed by car drivers (n=10, 31%). Nearly half of the patients injured as a passenger in a vehicle (n = 10, 45%) were under the age of 12, of which only 1 was secured in a child restraint. Most (75%) of the patients above age 12 were wearing seat belts. Pedestrians accounted for 30% (n=25) of road traffic injuries, cyclists accounted for 15% (n=12), and motorcyclists accounting for 11% (n=9). Of the bicycle and motorcyclists, 38% (n=8) were wearing helmets.

Most cases of falls happened in the age group of 0–14 and 25–44, while struck by or against object was the most common cause of TBI hospitalization among 0–14 and 15–24 age groups, most occurring among males (78%). The majority 25% (n=30) of injuries caused by struck by or against object occurred in a sports and athletics area, followed by home at 21% (n=25). Two-thirds of assault injuries took place in a public place, 5% (n=1) at workplace, 5% (n=1) at home and 17% (n=4) at other locations. The majority (78%) cases of assault occurred among males. The highest male: female ratio (3:1) was for injuries caused by assault (violence), and the lowest in falls (1.5:1)

Pre-hospital care

Ambulances were the source of hospital arrival for 60% of cases (n=328), and 27% arrived by private/public transport. For nearly a quarter (23%) of the TBI patients took less than 1 hour to reach the hospital. Most of the patients (29%) experienced an injury to arrival timeframe of 1–2 hours, 23% of patients took 2–4 hours, and 25% arrived more than four-hour post-injury. The mean GCS was 14.7 with 97% (n=525) suffering from mild TBI (GCS 13–15), 1% (n=5) with moderate TBI (GCS 9–12) and 2% (n=11) with severe TBI (GCS 3–8).

Emergency department assessment and treatment

Most patients had stable vital signs at arrival. Four percent was hypotensive (systolic blood pressure less than 90 mm Hg), 1.8% (n=10) were hypoxic (O2Sat less than 92%), and 0.7% (n=4) had fever (37.5°C and above). In 97% of the cases, the airway was clear, and breathing was spontaneous and adequate for 96% (n = 520). Among the patients with breathing insufficiency, intubation was performed for 2% (n=12) and manual breath support for another 1% (n = 4). Fluids were started for 2% (n=10), vasopressors in 2% (n=11) and CPR in only one patient (Table 3). Alcohol screening was performed in only 9% of cases, and only 3% of patients had indications of alcohol use, of which all were men and 75% were injured in a fall.

Inpatient diagnostic and treatment

A CT scan was performed for 430 (79%) patients and showed abnormalities in 85 (20%) cases. Out of these, the CT classification was indicated in 81 cases: diffuse injury, no visible pathology (NVP) was seen in 56% (n=45), diffuse injury in 27% (n=22), diffuse injury with swelling in 11% (n=9), diffuse injury with shift in 5% (n=4) and mass lesions in 1% (n=1); including subdural hematoma (n=15), epidural haemorrhage (n=13), and skull fracture (n=62). X-ray was performed for 43 cases and showed normal results for all (100%) patients

A number of 83% (n=451) patients sustained mostly isolated head injury, while the 17% (n=91) of patients had injuries involving multiple body regions. Surgery was performed for 19 patients (4%), while 36 patients (7%) had the surgery scheduled but not provided. Only non-operative treatment was provided for 168 patients. A number of 22 patients received

mechanical ventilation, and the 29 received antiseizure medication, hyperosmolar medication was provided for 168 patients. ICP monitor/ventriculostomy was placed only in1 patient. Daily therapy intensity was documented in 100% of cases. For 93% (n=506) of patients it was classified as therapy intensity level (TIL) 0, for 4% (n=21) as TIL 1 – Basic ICU care, for 2% (n=11) as TIL 2 – mild and for 1% (n=4) as TIL 3 – moderate

Outcome

The length of hospital stay (LOS) and discharge status were related to injury severity and varied from 0 to 37 days, the median duration of hospital stay was 1 day and the modal length of stay 1 day, respectively. Less than 1% of admitted TBI patients died, and 95% (n=509) were discharged to their home. The main cause of fatal TBI by mechanism was road traffic injury (4 of 6 deaths), of which two were car drivers wearing seatbelts, one was an unrestrained child, and one was a pedestrian. Of the two remaining deaths, one was an assault and one was work-related. Analysis of deaths by age and gender: 1 (0–14 years), 3 (25–44 years), 2 (45–64 years). All deceased patients were male. The patients with fatal TBIs presented at ED with varying GCS scales and varying duration from the time of injury occurrence. The GCS score ranged from 3 to 5, and only two patients were presented to the hospital within 1 hour after injury occurrence. The two patients experienced an injury to arrival timeframe of 2–4 hours, and 2 patients arrived more than 6 hours post-injury .

Demographic factors were all associated with length of stay ($p < 0.05$). Among the patients with hospital stays longer than 1 week, more than three quarters were male. Pediatric patients, who generally had lower TBI severity, had shorter lengths of stay than adults; 40% of 25–44 year old

and 27% of 45–64 year old were in the hospital for 15 days or more. Falls and road traffic injury had the longest lengths of hospital stay, and 47% of road traffic injuries led to a length of stay of 15 days or more. The longest lengths of stay were among patients who arrived at the hospital by ambulance, and those with the longest delays in hospital arrival (more than 4 hours) had the longest hospital stays.

Discussion

In Georgia, total health care expenditures are increasing every year, demonstrating rising demand for health services. The share of total health expenditures in GDP (%) is reasonably high; Georgia spends on healthcare practically as much as the European Region's high income countries (8%-9%). Although the government covers much of the care, there are still very high out of pocket payments which results in a heavy burden for households. Since 2006 the number of physicians per 100,000 population has been growing at a higher rate than in the European region. In contrast, from 1998 to 2013 the number of nurses per 100,000 population decreased and is lower than in European region and the CIS countries. Georgia is ranked second to last among European countries in the ratio of the number of nurses to physicians. Given the growth in the medical sector, opportunities exist to strengthen capacity for TBI treatment and care.

The participants in this survey, who represent the ten leading hospitals providing TBI care in Georgia, identified some common strengths and gaps in TBI care and capacity. These hospitals are high-volume, level I and II trauma centers located in urban areas. Nationally, Georgia has no defined framework for triage and treatment of TBI patients. The fact that most respondents were not aware of the designated national lead agency

on TBI treatment and care suggests that a lack of organization and cohesion of services could contribute to many of the observed gaps in care.

Hospital staff generally reported having full access to specialists and some diagnostic equipment needed to treat TBI patients, but it was apparent that the approach to care differs across hospitals. Respondents reported following different guidelines, variably noting local, national, or international guidelines. They reported no policies or legal frameworks to regulate treatment of TBI patients at a national level. Hospitals varied slightly with respect to their emergency-department organization, hospital facilities, treatment practices, leadership, and existing policies on TBI.

The ineffectiveness of rehabilitation services was the largest gap identified in TBI care. Others included access to services, quality of care, and financing of care. Also, given that all of the services were within one the large hospitals of a single city, patients living in rural areas are likely to have no access to TBI rehabilitation services.

Our study has limitations and strengths. Our survey took approximately 45 minutes, which is a significant time commitment for a specialist physician. Long questionnaires have been associated with lower data quality, mainly due to boredom of the respondents. A second potential limitation is that our results are likely not generalizable to other hospitals in Georgia, given that the hospitals were selected because they treated the largest TBI volume, and are not likely to be generalizable to other countries that have their own systems of care. We had one key informant in each hospital and responses may have differed with other participants. Study strengths included the engaged process of developing the survey

actively involving international partners and experts in the field. The survey was the first of its kind to document TBI capacity in Georgia and included a wide spectrum of care.

To the best of our knowledge, this is the first prospective TBI study to be conducted in Georgia. Our study conducted information in the two largest hospitals in Tbilisi, Georgia, designed to collect detailed TBI socio-demographic, epidemiologic, management and outcome characteristics employing an electronic data collection tool. Although the National Center for Disease Control and Public Health of Georgia (NCDC) collects data on hospitalizations, these data do not include details on the type, manner, and outcomes of traumatic injuries. Thus, registries such as this are critical to inform healthcare institutions, government leaders, and public health professionals about the trends and characteristics of TBI so that prevention and treatment priorities can be identified.

Georgia has a similar trend as other countries related to TBI. For example, men have higher TBIs than women, which might be related to societal roles and high engagement in risky activities. As with TBI registries in other countries, the majority of patients sustained mild TBI. Prior studies have found that many survivors of TBI have cognitive and physical symptoms, further contributing to the large body of evidence that even mild TBI is associated with long-lasting problems of functioning, especially among young children.

The results suggest that falls are the leading cause of TBI, while road traffic injuries rank first in mortality, which is similar to the findings from the published studies conducted in Northern Europe and the United States. The high incidence of fall-related TBIs among hospitalized patients highlighted the need for effective prevention strategies especially

among children, that will be targeted to reducing indoor and outdoor hazards as well as minimizing risk-taking activities.

Road traffic injury is the leading cause of TBI in LMICs, while in Georgia, despite the sharp growth of the road infrastructure over the last years, these are only in the 3rd place. According to the Ministry of Internal affairs of Georgia official data, the number of deaths caused by road traffic crashes decreased by 11% in 2018 compared to previous years. Using smart cameras for road traffic speed monitoring, zero tolerance to alcohol, criminalization of driving under the influence of drugs, introduction of a penalty points system, standard of using safety belts on front seat, and improving road infrastructure significantly affected the burden of road traffic injuries.

Violence-related TBIs might be misclassified and therefore underrepresented in this study. Violence, and especially domestic violence, is a stigmatized and a taboo subject in Georgian society. Also due to stigmatization, these data might also underestimate alcohol-related TBIs. Georgia is internationally recognized for its wine production and an important component of the economy, which may also be related to low hospital alcohol screening.

Most of the TBI patients arrived at the hospital by ambulance, and most of the patients who were brought in within 1 hour were taken by ambulance, thus, hospital phase can be positively assessed according to time of addressing and the quality of the data, vital signs were 100% filled. However, most of the severely injured patients had both a longer time to hospital arrival and longer lengths of stay. The Challenges of timely hospital arrival in LMICs are having various aspects and features as prior studies recognized, and include self-treatment practices, primary care

visits, and poor referral systems. The findings support the need for organized trauma systems that bring patients to trauma hospitals as quickly as possible. Future interventions, targeted on patient education regarding the time-sensitive nature of TBI could address the delays in seeking care.

The 99% (68 out of 69) of patients where CT scan or x-ray was not performed were very young children and clinically evaluated as mild TBIs and coded as concussions. The high percentage of scanned patients might be related to the financial accessibility of all emergency services including CT scan – which is an important tool for diagnosing and surgical decision-making processes, all of the emergency services are covered by the state program for all Georgian citizens. Thus, these patients would not need to make out-of-pocket payments as well as these high-standard hospitals would not have the logistical challenges.

A number of demographic and clinical variables of patients with TBI were associated with outcome. Besides the GCS score and extended time Interval between injury occurrence and hospital arrival, as a predictor of prolonged LOS and mortality in patients with TBI, other factors included lack of intracranial pressure monitoring. The patients with abnormal CTs requiring mechanical ventilation and surgical intervention needed longer lengths of hospital stay. All of the fatal outcomes were seen in severely injured TBI (GCS < 9) patients. Mortality rate of severe TBI was 54% which is higher than other low-income (40%) and high-income settings (28%). As the age of deceased patients ranged from 6 to 55 years, increased patient age did not seem to be related to mortality. These findings are consistent with the results of previously published studies. Contrasted with those studies lack of CT availability, failure to

receive surgery, and referral from another hospital were not factors associated with poor outcome in our settings.

One of the strengths of this study is that we were able to include all eligible TBI hospitalizations, and we had very little missing data. Our prospective study examined the TBI patients across over 70 variables and the data collectors have collected complete information about each patient based on medical histories/patients' charts as well as specifying details regarding missing variables in medical histories (ie place of injury occurrence), which helped to minimize the missing data.

The study also has some limitations that could influence the generalization of the results. This study was conducted with a small number of patients, in the limited time frame (6 months) of the research in the two largest multi-profile tertiary teaching hospitals located in the capital city, with low resource deficiency, thus it might not reflect what is happening in other settings especially in rural areas.

Furthermore, our numbers do not include the TBI patients who were seen in the emergency department (ED) and were not hospitalized or did not receive TBI-related care; thus these results are possibly underestimating the overall burden of TBI. We also have no follow-up of discharged patients; it is not possible to assess the long-term consequences of TBI among those patients as well as the true mortality rate.

There is a need for further studies using TBI registries which might expand and include all TBI in-patients and evaluate long-term outcomes of TBI for better understanding. Researchers suggest that organized trauma registries significantly reduce in-hospital and post-discharge mortality rates.

Conclusion

Even among the largest and most highly specialized hospitals in Georgia, variation in the structure and process of TBI care was reported. Particular gaps in pre-hospital triage and transport and in rehabilitation care were identified. Given growth in the health sector in Georgia, opportunities to fill gaps and standardize care are present.

In spite of the limitations, this study gives valuable insight into the burden and management of TBI in Georgia, provides a framework for TBI registry development, highlights areas for the research quality improvement, and provides information for policy makers regarding appropriate and effective preventive measures.