Research Protocol: Trauma Center Outcomes at Wolfson Hospital

Abstract

Background: Trauma injuries requiring emergency department care are highly prevalent and lead to high mortality and disability rates. While trauma centers have significantly reduced mortality, efforts continue to further lower these rates. National trauma registries and quality indicators enable epidemiological research to monitor changes. In Israel, the Gertner Institute centralizes trauma unit data. On August 27, 2017, Wolfson Hospital received a trauma report from the Institute highlighting mortality concerns: mortality for moderately injured patients was 3 times higher, and for mildly injured patients 8 times higher, compared to other regional trauma centers.

Objective: To examine the correlation between trauma injury characteristics, victim characteristics, and clinical outcomes. Injury characteristics include type and severity (ISS). Victim characteristics include age, sex, BMI, chronic diseases, and risk factors. Three outcomes were assessed: discharge destination, length of hospitalization (days), and expected recovery level.

Method: A retrospective epidemiological study was conducted using data from the Wolfson Hospital Trauma Unit database between January 1, 2016, and December 31, 2016. The sample included 1,508 patients aged 18 and older who were treated in the trauma room and hospitalized. Patients discharged on the same day were excluded. Statistical analysis was performed using SPSS, testing 24 correlations between variables.

Results: 54.4% of victims were women; the average age was 66.28, with 53.8% aged 70 or older. The average BMI was 26.81, with 42.10% being overweight. 69.8% were hospitalized due to falls and 17% due to road accidents. 57% of injuries were mild and 38.5% moderate. The mortality rate was 2.5% (37 victims). 75% were discharged home. Correlations were found between chronic diseases, injury type, and severity across all outcomes. Gender was linked to discharge destination, with more women referred to rehabilitation. Age correlated with length of stay and destination (older age led to longer stays and referrals to nursing/rehab facilities). BMI was positively correlated with hospitalization length.

Discussion and Conclusions: This study indicates that trauma victims at Wolfson Hospital in 2016 included more women, more patients over 70, and a higher rate of falls than reported by the Gertner Institute. The higher referral rate of women to rehabilitation may be linked to a lack of home support rather than clinical status alone. Chronic illnesses must be considered when predicting outcomes. Future research should examine "Structure" quality indicators and the specific causes behind gender-based discharge trends.

Introduction

Healthcare systems worldwide face the challenge of treating life-threatening injuries and resulting disabilities. According to the World Health Organization (WHO, 2014), five million people die annually from injuries—ten deaths every minute. Injuries account for 9% of global mortality. Millions of

individuals never return to their pre-injury health status. In the US (2010), there were 809,000 injury-related hospitalizations, with estimated costs reaching $586 billion in medical care and lost productivity (Boyd et al., 2017).

Trauma centers provide essential resuscitation and urgent care to reduce mortality and improve survival quality (Gruen et al., 2012). Quality of care is defined as the degree to which health services increase the likelihood of desired health outcomes consistent with current professional knowledge (WHO, 2009). Beyond the treatment itself, improvement involves organizational efficiency and accessibility.

In Israel, the National Center for Trauma and Emergency Medicine Research, managed by the Gertner Institute, monitors these trends. Wolfson Medical Center has participated in this registry since 2008. A recent report alerted the hospital management to the fact that mortality for moderate and mild injuries at Wolfson was significantly higher than the regional average (3 times higher for moderate and 8 times higher for mild).

This study aims to investigate the factors behind these findings to improve trauma care at Wolfson Hospital. The central research question is: What are the factors influencing the clinical outcomes and mortality rates of trauma victims at Wolfson Hospital in 2016?

Literature Review

1. Trauma Centers

1.1 Definition of Physical Trauma and Physiological Responses

Physical trauma is defined as bodily injury caused by external energy (NIH, 2018). It includes blunt, penetrating, and thermal trauma. Blunt trauma involves objects or forces causing lacerations or fractures, while penetrating trauma involves objects piercing the skin. Following an injury, the body undergoes systemic physiological changes intended for protection, compensation, and eventually, repair and recovery (Leenen, 2013).

1.2 Epidemiology of Trauma

1.2.1 Global Epidemiology: Road accidents are predicted to be the third leading cause of death globally by 2020. Half of all trauma deaths occur in the 15-45 age group (Fararoei et al., 2017).

1.2.2 Epidemiology in Israel: Reports show that one in three Israelis will be hospitalized for an injury during their lifetime. Between 2010 and 2015, injury rates increased by 8%, largely due to falls and road accidents. Mortality rates rise significantly for patients aged 55 and older, regardless of injury severity (Peleg et al., 2016).

1.3 Historical Background of Trauma Centers

Modern trauma systems emerged in the 1960s. The 1966 document "Accidental Death and Disability: The Neglected Disease of Modern Society" catalyzed the development of emergency medical services (EMS) and trauma protocols like Advanced Trauma Life Support (ATLS).

1.4 Quality Indicators

Common indicators include hospital mortality, complications, and time to treatment (e.g., CT scan within 1-4 hours). However, because overall survival rates have improved, mortality alone is no longer the sole measure of quality; long-term survival and quality of life are becoming equally important (Gruen et al., 2012).

1.5 Trauma Center Grading and Wolfson Hospital

Trauma centers are graded Level 1 (Supra-regional), Level 2 (Regional), or Level 3 (General). Wolfson Hospital operates as a Level 2 Regional center. Between 2015-2017, the ER underwent renovations, adding a trauma room with three beds and advanced equipment (FAST, ventilators, etc.). The unit is staffed by a manager, a coordinator, and a dedicated team of surgeons and nurses.

1.6 Injury Characteristics: Type and Severity

Survival and outcomes are linked to patient demographics (age, sex) and clinical status (GCS, blood pressure). The Injury Severity Score (ISS) is a primary predictor of recovery and discharge destination.

1.7 Treatment Outcomes for Trauma Victims

1.7.1 Discharge Destination: Factors such as pre-injury function and social support often dictate whether a patient is discharged home or to a rehabilitation/nursing facility.

1.7.2 Length of Hospitalization: Older age, chronic illness, and high BMI are known predictors of longer hospital stays (Bergeron et al., 2005; Lee et al., 2016).

1.7.3 Expected Recovery Level: While many survive, many are left with disabilities. Studies show that ISS and age are major factors in determining whether a patient achieves full recovery or faces long-term disability.

1.8 Research Objectives and Question

The objective is to examine the relationship between victim/injury characteristics and outcomes (discharge destination, length of stay, recovery level).

Question: What is the relationship between trauma injury characteristics, victim characteristics, and the outcomes of patients hospitalized at Wolfson Hospital in 2016?

Methodology

1. Study Type

A retrospective epidemiological study analyzing data from January 1, 2016, to December 31, 2016.

2. Study Population

Total sample: 1,508 patients from the Wolfson Hospital Trauma Unit database.

Inclusion: Adults (18+), treated in the trauma room and hospitalized.

Exclusion: Patients discharged on the same day as admission.

3. Research Variables

Independent Variables:

Victim Characteristics: Age (18-30, 30-50, 50-70, 70-90, 90+), Sex, BMI (Underweight, Normal, Overweight, Obese, Morbidly Obese), Chronic Diseases (0, 1, 2, 3+), Risk Factors.

Injury Characteristics: Type (Fall, Road Accident, Violence, Burns, Other), Severity (ISS: 1-6 Mild, 8-14 Moderate, 16-24 Severe, 25-75 Very Severe).

Dependent Variables (Outcomes):

Discharge Destination: Home, Rehab, Nursing facility, Other hospital, Death.

Recovery Level: Full recovery, Mild disability, Severe disability, Death.

Length of Hospitalization: Total days.

4. Research Tools

Data registry/database of the Trauma Unit at Wolfson Hospital.

5. Research Procedure

Extraction of data into Excel for statistical organization and subsequent analysis.

6. Ethics

The study was approved by the Helsinki Committee (Appendix 1).

7. Statistical Data Processing

Data were analyzed using SPSS. Tests included descriptive statistics (percentages, means), Chi-square, Pearson correlations, T-tests, and F-tests to examine 24 different correlations.

Findings

The findings chapter is divided into two parts: The first part presents the personal, clinical, and injury characteristics of the study participants. The second part presents the correlations between the victim's characteristics (demographic and clinical) and injury characteristics with the outcomes: discharge destination, length of hospitalization in days, and expected recovery level.

Part One: Patient Characteristics

Patient Characteristics

Demographic Characteristics

Analysis of the study participants (n=1,508) reveals that 54.4% were women and 45.6% were men. Approximately one-quarter of the hospitalized patients were aged 50 or younger, 21% were between 50-70 years old, nearly half (45.9%) were in the 70-90 age range, and 7.9% were over 90 years old. The age of hospitalized individuals ranged from 18 to 106, with a mean age of 66.28 (SD=21.91).

Furthermore, the majority of subjects were Jewish (93.8%), Israeli citizens (96.4%), born abroad (66.8%), and residents of the central region of Israel (95.3%). Notably, the percentage of women hospitalized due to injuries (54.4%) was higher than that of men (45.6%).

Clinical Characteristics

The distribution of patients by Body Mass Index (BMI) showed that 35.41% had a normal weight, while 42.10% were overweight. A very small number of subjects (3.05%) were underweight. It is important to note that for a significant portion of the subjects (19.42%), data regarding BMI calculation was missing. The mean BMI of the study participants was 26.81 (SD=14.86).

1.3 Injury Characteristics and Discharge Destination

The majority of subjects were hospitalized due to falls (69.8%), followed by road accidents (16.9%), violence (4.2%), and burns (0.1%). Regarding injury severity (ISS), 56.7% of hospitalized patients had mild injuries, while 38.5% were categorized as moderate. Only 4.9% suffered from severe or very severe injuries.

In terms of risk factors, 86.5% had no documented risk factors. Regarding the discharge destination, approximately three-quarters (75.1%) were discharged to their homes, while about one-fifth were transferred to a rehabilitation or nursing facility. The mortality rate was 2.5% (37 victims).

Part Two: Correlations Between Research Variables

This section presents the correlations between the patients' personal characteristics (sex, age, BMI, risk factors, chronic diseases) and injury characteristics (type and severity) with the clinical outcomes.

2.1 Correlation Between Victim Characteristics and Discharge Destination

2.1.1 Clinical and Demographic Characteristics

Age: A significant correlation was found between the patient's age and the discharge destination [$F(5,1502)=30.05$, $p<0.01$]. The average age for those discharged home was 62.96, while the average age for those transferred to rehabilitation or nursing facilities was over 75.

Sex: A significant correlation was found between gender and discharge destination [$\chi^2(5)=44.41$, $p<0.01$]. The rate of men discharged home (80.5%) was higher than that of women (70.6%). Conversely, women (25.5%) were transferred to rehabilitation facilities at a higher rate than men (13.4%).

BMI: No significant correlation was found between BMI and discharge destination [$\chi^2(10)=15.33$, $p=0.12$].

Risk Factors: A significant correlation was found between the number of risk factors and the discharge destination [$\chi^2(15)=31.85$, $p<0.01$].

Chronic Diseases: A significant correlation was found between the number of chronic diseases and the discharge destination [$\chi^2(15)=108.02$, $p<0.01$]. Most patients without chronic diseases (82.5%) were discharged home compared to those with three or more diseases (67.1%).

2.1.2 Injury Characteristics and Discharge Destination

6. Injury Type: A significant correlation was found between the type of injury and the discharge destination [$\chi^2(20)=127.29$, $p<0.01$]. Approximately 25% of fall victims were transferred to rehabilitation compared to 5% of road accident victims.

7. Injury Severity: A significant correlation was found between injury severity and discharge destination [$\chi^2(15)=191.66$, $p<0.01$]. While 85.4% of mildly injured patients were discharged home, only 46.2% of those with very severe injuries were. Notably, 23.1% of patients with very severe injuries died.

2.2 Correlation Between Victim Characteristics and Length of Hospitalization (Days)

2.2.1 Clinical and Demographic Characteristics

Age: A significant positive correlation was found between age and length of stay ($r=0.23$, $p<0.01$); as age increases, the duration of hospitalization lengthens.

Sex: No significant differences were found between gender and length of stay [$t(1504)=-0.97$, $p=0.33$].

BMI: Significant differences were found in the length of stay between patients with different BMI categories [$F(2, 1212)=3.32$, $p<0.05$], with normal-weight patients staying slightly longer ($M=6.80$) than overweight patients ($M=5.85$).

Risk Factors: No correlation was found between risk factors and length of stay ($r=-0.01$, $p=0.10$).

Chronic Diseases: A significant positive correlation was found between the number of chronic diseases and length of stay ($r=0.14$, $p<0.01$).

2.2.2 Injury Characteristics and Length of Hospitalization

6. Injury Type: Significant differences were found [$F(4, 1492)=12.32$, $p<0.01$]. Patients hospitalized due to falls stayed significantly longer ($M=6.93$ days) than those involved in road accidents ($M=4.34$ days).

7. Injury Severity: Significant differences in the average length of stay were found based on injury severity [$F(3, 1502)=55.73$, $p<0.01$]. Patients with very severe injuries stayed the longest ($M=17.46$ days).

2.3 Correlation Between Subject Characteristics and Expected Recovery Level

2.3.1 Clinical and Demographic Characteristics

Age: No significant correlation was found [$F(4, 1503)=10.94$, $p<0.01$] regarding recovery level categories.

Sex: No significant correlation was found [$\chi^2(4)=5.66$, $p=0.23$].

BMI: No significant correlation was found [$\chi^2(8)=8.70$, $p=0.37$].

Risk Factors: No significant correlation was found [$\chi^2(12)=17.99$, $p=0.12$].

Chronic Diseases: A significant correlation was found [$\chi^2(12)=95.21$, $p<0.01$]. 97.2% of those without chronic diseases were expected to reach full recovery, compared to 79.7% of those with three or more diseases.

2.3.2 Injury Characteristics and Expected Recovery Level

6. Injury Type: A significant correlation was found [$\chi^2(16)=27.56$, $p<0.05$]. Those expected to reach full recovery were primarily victims of falls (93.3%) or road accidents (94.5%).

7. Injury Severity: A significant correlation was found [$\chi^2(12)=274.34$, $p<0.01$]. 95.6% of mildly injured patients were expected to fully recover, compared to 61.5% of those with very severe injuries.

Summary of Findings

In summary, age, BMI, and injury severity (ISS) were significantly associated with the length of hospitalization. Gender, age, chronic diseases, injury type, risk factors, and ISS were associated with the discharge destination. Furthermore, chronic diseases, injury type, and ISS were significantly associated with the expected recovery level. Notably, chronic diseases and injury characteristics (type and severity) were the only factors significantly correlated with all three assessed outcomes.

Table 1. Expected Recovery Level by Injury Severity

Injury Severity	Full Recovery	Mild Disability	Severe Disability	Not Assessed	Death
Mild	817 (95.6%)	4 (0.5%)		22 (2.6%)	12 (1.4%)
Moderate	540 (93.1%)	4 (0.7%)		17 (2.9%)	19 (3.3%)
Severe	50 (83.3%)	1 (1.7%)		6 (10.0%)	3 (5.0%)
Very Severe	8 (61.5%)		2 (15.4%)		3 (23.1%)

Table 2. Expected Recovery Level by Chronic Diseases

Chronic Diseases	Full Recovery	Mild Disability	Severe Disability	Not Assessed	Death
None	881 (97.2%)	5 (0.6%)	2 (0.2%)	10 (1.1%)	8 (0.9%)
One	326 (93.4%)	3 (0.9%)		11 (3.2%)	9 (2.6%)

Two	145 (83.3%)			16 (9.2%)	13 (7.5%)
Three or More	63 (79.7%)	1 (1.3%)		8 (10.1%)	7 (8.9%)

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224 **Table 3. Discharge Destination by Risk Factors**

Risk Factors	Home	Rehab Facility	Nursing Facility	Other Hospital	Death	Other
None	968 (74.2%)	271 (20.8%)	17 (1.3%)	5 (0.4%)	35 (2.7%)	9 (0.7%)
One	151 (81.6%)	28 (15.1%)	2 (1.1%)		2 (1.1%)	2 (1.1%)
Two	13 (76.5%)	2 (11.8%)				2 (11.8%)
Three or More	1 (100%)					

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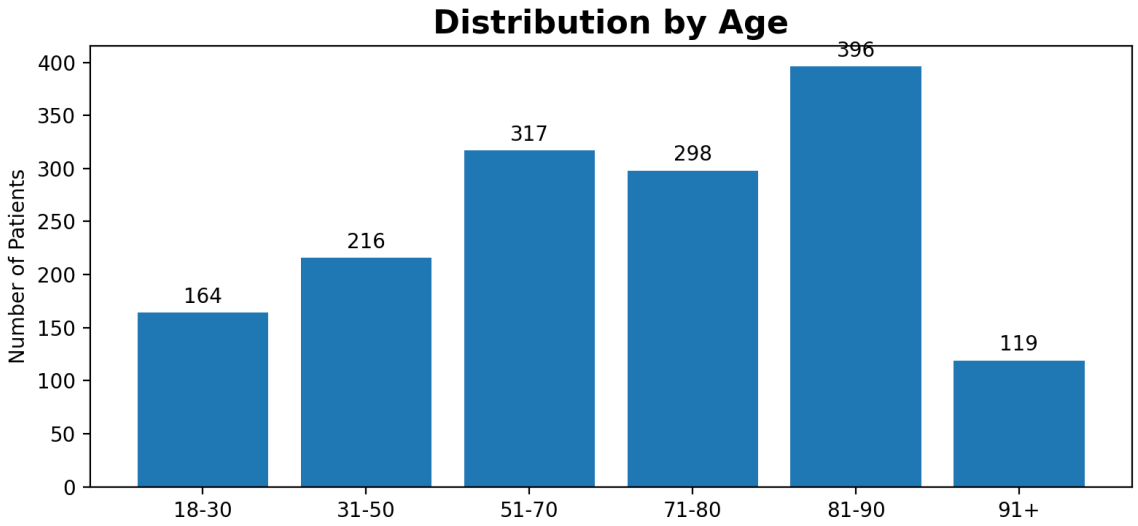

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227 *Figure 1. Distribution by Age*

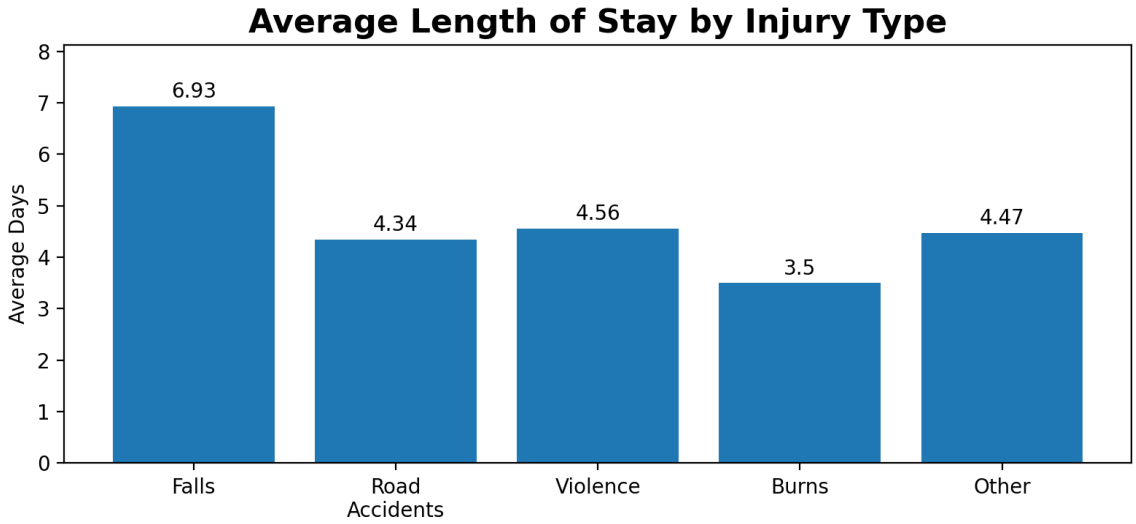

Figure 2. Average Length of Stay by Injury Type

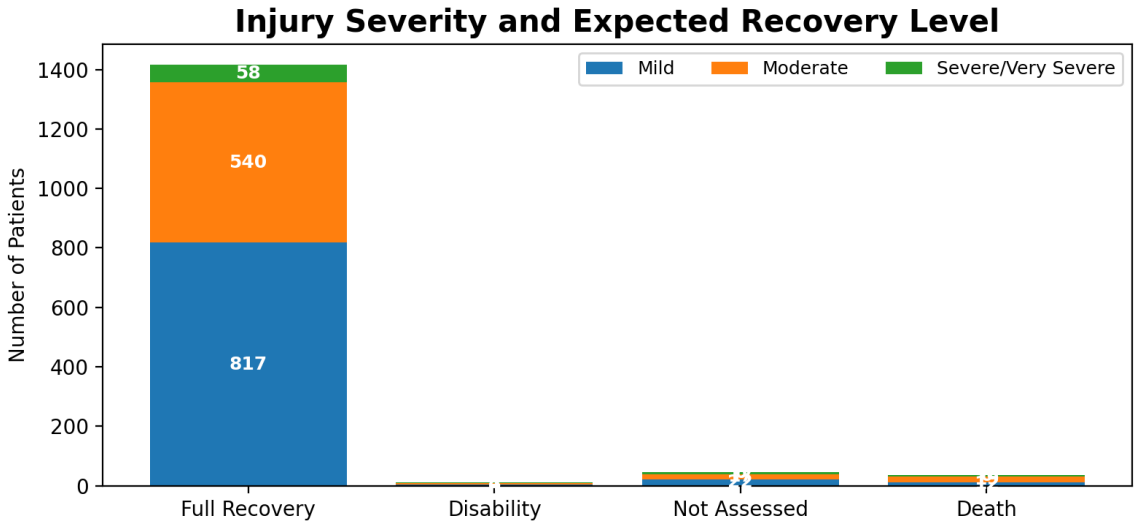

Figure 3. Injury Severity and Expected Recovery Level

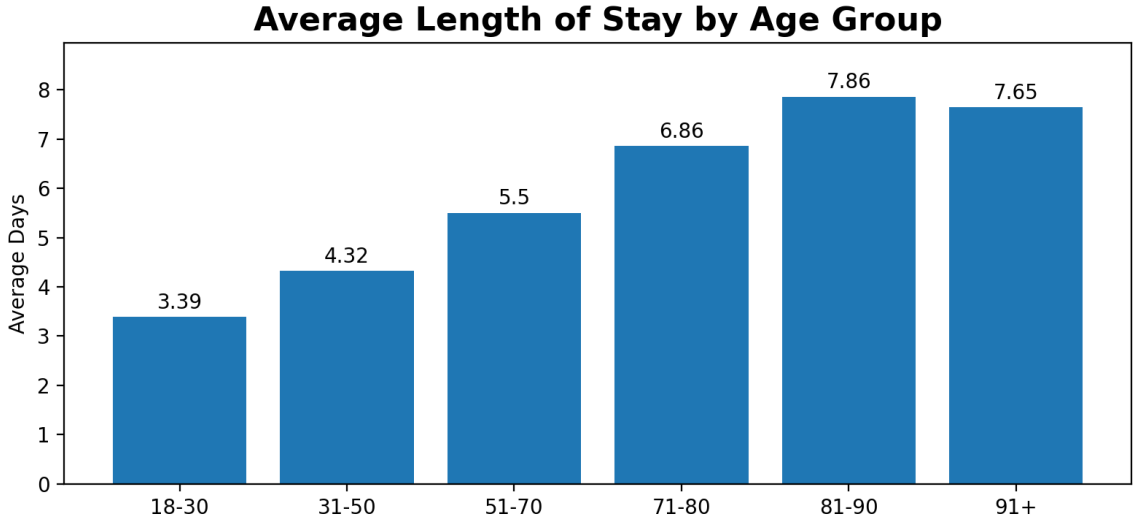

Figure 4. Average Length of Stay by Age Group

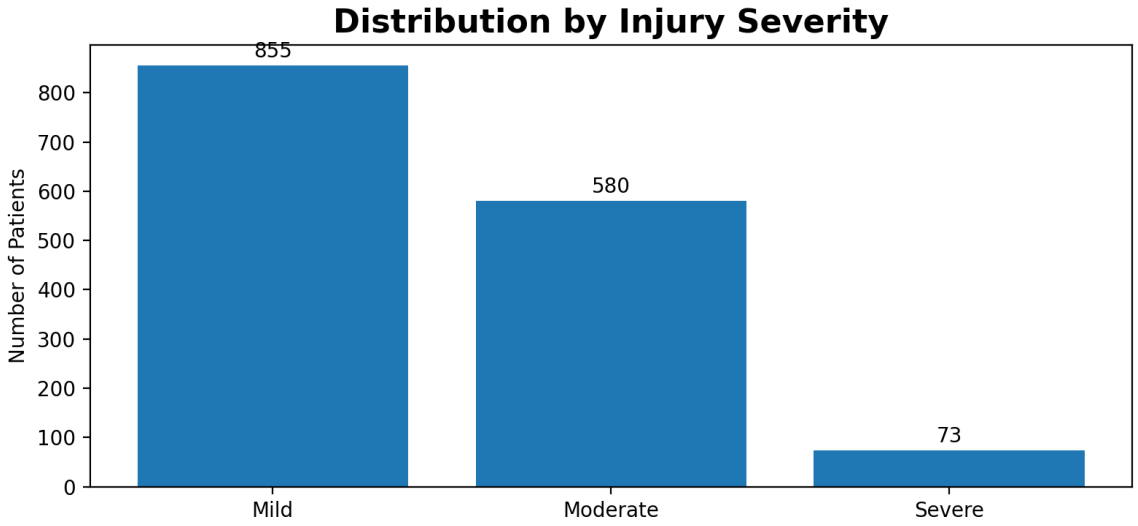

Figure 5. Distribution by Injury Severity

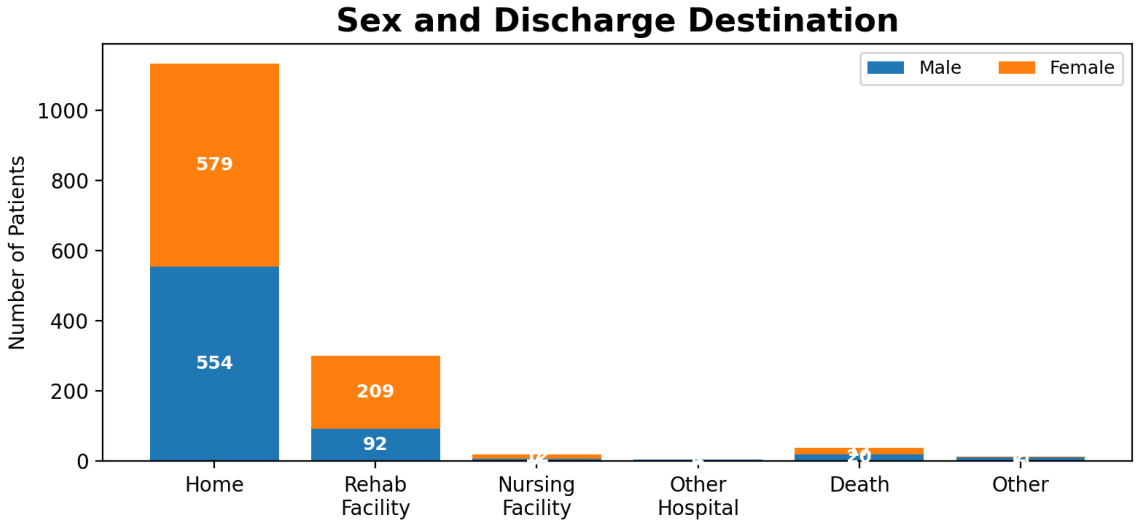

Figure 6. Sex and Discharge Destination

Discussion

The primary objective of this study was to examine the relationship between trauma injury characteristics, victim characteristics, and clinical outcomes for patients hospitalized at Wolfson Hospital in 2016. Beyond the global importance of trauma research due to its associated mortality and disability (Boyd et al., 2017), this study was initiated following findings from the Gertner Institute. These findings indicated that mortality rates at Wolfson Hospital were eight times higher for mildly injured patients and three times higher for moderately injured patients compared to other trauma centers.

To address the research goal, trauma injuries were analyzed by type and severity. Victim characteristics included age, sex, BMI, chronic diseases, and risk factors. The three outcomes examined were discharge destination, length of stay (days), and expected recovery level. Out of the 24 correlations tested, several key findings emerged: chronic diseases, injury type, and injury severity were significantly linked to all three outcomes. Specifically, regarding discharge destination, more women were referred to rehabilitation facilities compared to men. BMI was associated with longer hospital stays but not with expected recovery. Additionally, age was found to correlate with both length of stay and discharge destination. This discussion is organized into three main themes based on the research outcomes.

1. The Relationship Between Victim/Injury Characteristics and Discharge Destination

The analysis revealed that discharge destination is linked to sex, age, chronic diseases, risk factors, injury type, and severity. In contrast, no correlation was found with BMI, suggesting that a patient's weight is not a primary consideration in determining discharge placement. These findings support the report by Zarshenas et al. (2017), which noted that factors related to the individual rather than just clinical status often influence discharge destination.

The results align with existing literature; for instance, Chen et al. (2012) found that age significantly impacts discharge, noting that patients over 65 often do not return home but are referred to rehabilitation or nursing facilities. Similarly, this study found that from age 63, patients are less likely to return home, and above age 75, they are predominantly referred to nursing or rehab centers. This is explained by the increased complexity of recovery and restoration of pre-injury status in older populations.

Regarding gender, while Zarshenas et al. (2017) found that women were often discharged to "other" non-rehabilitative institutions, this study found that 25.5% of women were referred specifically to rehabilitation, compared to only 13.4% of men. A possible explanation for the higher rate of non-home discharges among women may be their marital or social status. Given that women have a higher life expectancy, they are more likely to be widowed or living alone without a partner to provide home care. Conversely, men are more likely to have a spouse available to support them, reducing their need for institutional rehabilitation.

Furthermore, this study found that as injury severity increases, the likelihood of referral to a rehab or nursing facility also increases, consistent with Recker et al. (2018). Interestingly, patients with moderate injuries were referred to rehabilitation more frequently than those with severe or very severe injuries. This may be due to a higher "cost-benefit" ratio, where moderately injured patients have a higher probability of successful rehabilitation, whereas severely injured patients may require long-term nursing care instead.

2. The Relationship Between Victim/Injury Characteristics and Length of Hospitalization

The study found that age, BMI, chronic diseases, injury type, and severity are all linked to the duration of hospitalization. No correlation was found with risk factors. These findings largely support previous research by Bergeron et al. (2005), Chen et al. (2012), and Hwabejire et al. (2013), which established that older age leads to longer stays due to slower recovery and higher prevalence of comorbidities.

Regarding BMI, while Lee et al. (2016) suggested that normal-weight patients stay longer, this study aligns with Chabok et al. (2014), finding that overweight patients have longer stays, potentially due to their higher risk for chronic illnesses. Regarding severity, the positive correlation between ISS and length of stay matches the findings of Bergeron et al. (2005). While some international studies suggest that long stays are often due to administrative or financial delays (Hwabejire et al., 2013), the Israeli context—under the National Health Insurance Law—minimizes financial barriers. However, availability of rehab beds remains a potential factor for future investigation.

3. The Relationship Between Victim/Injury Characteristics and Expected Recovery Level

Chronic diseases and injury characteristics (type and severity) were found to be significantly associated with the expected recovery level. Age, sex, BMI, and risk factors did not show a significant correlation. Comparing these results to literature is challenging due to the lack of standardized global tools for predicting short-term recovery (Gabbe et al., 2015). However, as noted by Erem et al. (2017), injury severity remains the most reliable predictor: higher severity leads to a poorer prognosis.

Unlike Chabok et al. (2014), this study did not find a link between BMI and recovery level. This discrepancy may be methodological, as this study used international BMI categories, whereas Chabok et al. used a binary division (above/below 30). Surprisingly, age did not correlate with recovery level in this sample, despite its strong link to discharge destination and length of stay. This warrants further investigation in future studies.

4. Study Sample vs. Gertner Institute Reports

A comparison between this 2016 sample and the Gertner Institute's 2010-2015 reports reveals significant demographic differences. In this study, 54.5% of victims were women, compared to 39.7% in the national report—a 15% difference. This gap likely stems from the specific elderly population served by Wolfson Hospital.

While the Gertner reports show that 19% of trauma victims nationwide are aged 75+, Wolfson Hospital's sample showed that 53.8% of victims were aged 70+. This 35% surplus in elderly patients at Wolfson is a critical finding. It explains the higher proportion of women and the increased incidence of falls (60% at Wolfson vs. 48% nationally). As the Gertner Institute itself noted, Wolfson serves a "particularly high percentage of elderly and very elderly patients," which likely accounts for the higher mortality rates in the mild and moderate injury categories.

5. Study Limitations

The primary limitation is the retrospective nature of the study, which allows only for correlational analysis. Additionally, some clinical characteristics or interactions between variables may not have been captured. While international studies often use multi-year datasets, this study focused on a single year.

Furthermore, using Donabedian's quality framework, this study focused on "Process" (age, BMI, chronic disease) and "Outcome" (mortality, discharge) indicators. "Structure" indicators (staff-to-patient ratios, professional experience) were not examined. This represents a limitation but also an opportunity for future organizational research.

Summary and Recommendations

The conclusions of this study indicate that discharge destination, length of hospitalization, and expected recovery level are influenced not only by clinical factors but also by patient demographics. Each outcome provides a different perspective on trauma care quality. As mortality rates decrease globally, discharge destination has become a vital measure of disability and quality of life.

Chronic diseases and injury characteristics (type and severity) emerged as the most consistent predictors of all three outcomes. The finding that women are referred to rehabilitation at higher rates than men does not necessarily imply poorer physiological recovery, but rather suggests a potential lack of home-based support systems.

The significantly higher age of trauma patients at Wolfson Hospital compared to other centers likely explains the mortality anomalies reported by the Gertner Institute. From a policy perspective, healthcare systems must prepare for the increasing demand for rehabilitative and nursing facilities as the elderly population continues to grow.

Recommendations:

For Professionals: Greater emphasis should be placed on managing chronic diseases alongside acute trauma care to improve prognosis.

For Future Research: Future studies should integrate "Structure" quality indicators (such as staffing levels and unit organization) to obtain a holistic view of the factors affecting trauma outcomes.

For Wolfson Hospital: This data provides a foundational understanding of the unique patient mix at the trauma unit, supporting continued efforts to refine care protocols for the elderly and reduce mortality.

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(Note: Hebrew sources have been transliterated/translated for consistency)

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