Prehospital Transportation and Care of Externally-Caused Injuries Admitted to

Karapitiya Teaching Hospital in Galle, Sri Lanka

by

Lindy Reynolds

Duke Global Health Institute
Duke University

Date:_______________________
Approved:

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Catherine Staton, Supervisor

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Truls Østbye

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Charles Gerardo

Thesis submitted in partial fulfillment of
the requirements for the degree of
Master of Science in the Duke Global Health Institute
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2018

ABSTRACT

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Abstract

Background: Injuries account for about 13% of all registered deaths in Sri Lanka, and are the leading cause of admission to public hospitals. Each year, 62,377 people with injuries require inpatient care in the Galle district. The prehospital trauma care system is new to Sri Lanka and a free ambulance service was launched about two years ago, with most ambulances concentrated in the larger cities around major hospitals. Objective: The objective of this study was to describe the prehospital transportation and care of people with externally-caused, acute injuries and examine factors associated with ambulance transport the first health facility. Methods: A cross-sectional survey, with a small longitudinal component was administered to 405 patients that were admitted the emergency trauma center at Teaching Hospital Karapitiya in Galle, Sri Lanka. Information on patients' medical treatment and length of stay were extracted from the medical records. Descriptive statistics were tabulated to summarize prehospital transportation and care variables. Logistic regression was used to examine predictors of ambulance transport, and negative binomial regression was used to examine transport time, mode of transport, and prior medical care as effect modifiers of injury event and length of stay relationship. Results: Over 50% of people used a tuk-tuk to get to the first health facility, and 20.5% used an ambulance to get to the first health facility. Factors that were significantly associated with ambulance use were age, injury mechanism, alcohol, location type, open wound, abrasion, and chest/abdomen injury. Ambulance transport and prior medical treatment were significant effect modifiers for open wound and fractures. Conclusion: Ambulance transport and prior medical treatment of fractures and open wounds were associated with a shorter length of stay which could help alleviate the burden on already constrained resources at tertiary care facilities.

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List of Abbreviations

DALYs	Disability Adjusted Life Years
EMS	Emergency Medical Services
ETC	Emergency Trauma Center
IPV	Intimate Partner Violence
LMIC	Low and Middle Income Countries
RTI	Road Traffic Injury
TBI	Traumatic Brain Injury
THK	Teaching Hospital Karapitiya
WHO	World Health Organization
YLLs	Years of Life Lost

1. Introduction

1.1 Global and Regional Burden of Injuries

Globally, approximately 5 million people die each year from injuries, which accounts for 9% of all deaths and more people die each year from injuries than from HIV/AIDS, tuberculosis and malaria combined[1]. Additionally, both road traffic injuries and falls are predicted to rise in rank for leading causes of death by 2030, with road traffic injuries being predicted to become the 7th leading cause of death and falls are anticipated to move from the 21st leading cause of death to the 17th leading cause of death[1]. Injuries are among the top ten causes of years of life lost (YLLs) in nearly all countries in Asia and account for 10% of all deaths in the South-East Asia region[1]. Overall, the top three leading causes of injury related deaths in Asia include road traffic incident, self-harm, and falls. Other forms of injury include interpersonal violence, stab or cut, electric shock, drowning, poisoning, animal bites, burn, and other blunt forces. In Sri Lanka self-harm, road traffic injury, and interpersonal violence are the second, eighth, and ninth leading cause of YLLs respectively[2]. Road traffic incidents account for 2.96% of deaths, self-harm accounts for 1.63% of deaths, and falls are responsible for 0.96% of deaths in the region.

In South Asia, road traffic crashes kill about 316,000 people each year which accounts for 25% of road traffic deaths worldwide[3]. The road traffic death rate per

100,000 people in South-East Asia is 17.0 which is below the global average of 17.4[3]. In Sri Lanka, the road traffic fatality rate is 17.4 per 100,000 which is slightly above the regional average but equal to the world average[3]. This rate varies from country to country, but is lowest in Maldives (3.5 per 100,000) and highest in Thailand (36.2 per 100,000). Some countries lose up to 3% of their GDP per year from road traffic injuries[3]. According to WHO estimates, about 3700 people die each year in road traffic crashes in Sri Lanka[3].

Interpersonal violence substantially contributes to the injury burden in South-East Asia. Specifically, 37.7% of women in this region will experience physical or sexual violence by a partner or non-partner in their lifetime, and the highest prevalence of intimate partner violence is seen in the 40 to 44 age group, followed by 35 to 39 [4]. In South Asia, IPV is viewed primarily within the context of marriage and prevalence estimates of IPV vary from 20 to 72%[5]. One review found that the prevalence of IPV in Sri Lanka is approximately 33% which is slightly below regional prevalence estimates [4, 5]. In addition to interpersonal violence, self-harm substantially contributes to the overall injury burden in South-East Asia region. The region contains about 25% of the world's population, but is responsible for 39% of the world's suicides annually [6].

The 3rd leading cause of injury-related death each year is falls, with about 650,000 people dying each year from falls [7]. Over ¾ of these deaths occur in low and middle income countries[7]. A review on falls found that the occurrence of falls in the South-East Asia region ranges from 18.7% among older people living in a community in Thailand to 53.6% of people in the Philippines [8]. In Sri Lanka, falls are the leading cause of both fatal and non-fatal injuries in older populations[9].

Another group of injuries that contributes to the overall injury burden in South Asia is poisonings via pesticides, pharmaceutical agents, and household products. There is significant regional variation in the burden of injury due to poisonings. In Bhutan, poisonings are the third largest contributor to YLLs, while other studies in Malaysia, India, and Sri Lanka have shown that it is less of a contributor to overall injury burden [10-12]. Incidence of pesticide ingestion have been steadily declining in Sri Lanka since the passing of regulations that ban the most toxic compounds [13].

In addition to fatal injuries, non-fatal injuries contribute to the overall disease burden and are the leading cause of hospital admissions in Sri Lanka with 62,377 non-fatal injuries requiring in-patient care in the Galle district alone[14]. A cross-sectional survey aimed at identifying the different types of injuries in the Galle district found that incidence of non-fatal injury is higher in rural areas and among men, with leading causes of non-fatal in this region of Sri Lanka including falls, mechanical injuries, road traffic injuries[14]. Other injury types reported in this study were animal bites, electricity related, and choking injuries[14]. A rural community based injury incidence study in the

Central Province near Kandy found that the most common injury mechanisms were due to dog bites, followed by falls and heavy objects falling on a person and that community based incidence estimates of physical injuries were higher than those of hospital based injury incidence estimates[15]. In addition to dog bites, there is a relatively high incidence of snake bites in Sri Lanka with one community-based nationwide survey estimating that 80,000 bites occur each year[16, 17]. While the incidence and burden of different types of injuries in Sri Lanka is well documented through previous studies[2-5, 13-17], far less is known about what happens to people with injuries before they get to the hospital.

1.2 Prehospital Trauma Care Systems

Prehospital refers to the time period from the medical emergency until arrival at the hospital, and prehospital system can be defined as "the comprehensive system which provides the arrangements of personnel, facilities and equipment for the effective, coordinated, and timely delivery of health and safety services to victims of sudden illness or injury" [18, 19]. Comprehensive emergency medical systems (EMS) are complex, have many different components, and require many resources to sustain them to have a positive effect on patient outcomes. Critical components to a functioning EMS system include personnel, pre-hospital care, equipment and communication needs, transportation, and health facilities [19-21]. It has been estimated that between 50-75% of the world's population do not have access to formal EMS systems[22, 23].

Prehospital systems can often be categorized into two broader models (Franco-German & Anglo-American), and each model operates under different philosophies [19]. Under the Franco-German model, more patients are treated on the scene, medical doctors (supported by paramedics), and fewer patients are transferred to the hospital [19, 21]. The Anglo-American model of EMS entails fewer patients being treated at the site of injury, care is provided by paramedics with oversight by doctors, and patients are typically transported to the emergency department [19]. In addition to the Franco-German and Anglo-American models, there are tiered model approaches for delivering emergency care in high-resource settings as well as resource-limited settings[19, 21]. In different EMS systems, prehospital care is provided by people with various levels of training (first responder, EMT-Basic, EMT-intermediate, Paramedic) [21]. The level of training of the person who provides this care varies from country to country, as well as within a single country's EMS system[21]. In one-tiered EMS systems all calls are responded to with the same level of life support, and it can be advanced life support (ALS) or basic life support (BLS) [19, 21]. Some countries a have mixed tiered system and in these models first responders may respond to calls first, followed by people who can provide a higher level of life support [19, 21].

Prehospital systems vary from country to country based on the qualifications of people who provide care, how patients are transported, where care is provided. Certain aspects of prehospital care have been linked with better patient outcomes and less of the worldwide trauma burden occurs in high income countries with developed trauma care systems[1, 19, 21]. According to World Health Organization estimates, about 5.8 million people die each year from injuries with 90% of deaths occurring in LMIC, many of which do not have developed trauma care systems[1].

1.3 Prehospital Transportation and Care in LMIC

Without an established ambulance service, there is no easy way for people to travel to the hospital. Some countries have ambulance services, but the qualifications of the people who operate the ambulance vary and overall ambulance utilization rates are typically lower when compared with higher income countries[24, 25]. With limited access or awareness about an ambulance service or emergency medical system, patients use other methods including but not limited to personal car, public transportation, walking, taxis, police vehicles, or trucks[26-29]. The most common form of taxi in Sri Lanka is a three-wheel motorized rickshaw called a tuk-tuk. The mode of transportation a person uses to get to the hospital is associated with distance traveled to hospital as well as time from injury to presentation at the hospital [26, 27, 29]. Prehospital time from time of injury event to arrival at a health facility vary widely, with estimates ranging under one hour up to several days[26, 29]. Additionally, in the absence of emergency medical services, patients are often accompanied by relatives, bystanders, police, or friends to the hospital and the group of people that accompanies patients to the hospital is time-dependent, with more bystanders and police transporting patients within the first six hours of the injury event[26, 27]. Beyond six hours of the injury event, relatives are responsible for the majority of patient transport[29]. In addition to many different groups of people traveling with the patient to the hospital, there is also considerable diversity in the proportion, type, and location of care people receive prior to arriving at the hospital[30-32]. Furthermore, in countries with no formal ambulance services, more than half of patients do not receive any care prior to arriving at the hospital[27, 33].

Many different interventions to improve and help develop EMS have been implemented in LMIC with the goal of improving patient outcomes. Some of the interventions include community based first aid trainings [34, 35], first aid courses for commercial and taxi drivers[22, 36], and modifying existing ambulance services into a more efficient system[37].

1.4 Prehospital Transportation and Care in Sri Lanka

The emergency medical system in Sri Lanka is relatively new and there is a wide variety in how people arrive at the hospital. Consequently, there is considerable diversity in where and the type of care people receive before arriving at the hospital[15, 30, 31, 38]. In the northernmost district of Jaffna, a prehospital EMS system was implemented in February 2009 and responded to 2,124 incidents in the first 11 months of operation, but there are some concerns with regards to financial stability of the program[38]. In 2011, a board was established with the purpose of developing an emergency medicine training program[30]. As of 2013, there was one government official in charge of EMS for the entire country[31]. A substantial portion of EMS are either untrained or only trained in basic life support, and people use commercial, private, and non-motor vehicles to get to the hospital[31]. Training for first responders is typically basic first aid, and there is no certification required for EMS providers[30, 31]. In 2016, the government of India gave a grant of 7.6 million USD to develop an ambulance service that would serve the people of Sri Lanka for free and employ 250 EMTs, 250 pilots, as well as 50 call center operators [39]. There are many obstacles to developing emergency medicine in Sri Lanka some of which include the lack of emergency medical physicians, emergency phone number does not cover the whole country, lack of training for emergency personnel and lack of recognition that emergency medicine as a primary specialty[30].

1.5 Study Aims

Without a formal EMS system, data on prehospital transportation and care are not readily available. This study will attempt to describe the transportation and care of those with externally-caused, acute injuries, examine characteristics of the injury and injury event in addition to patient demographics as predictors of prehospital transportation and care, assess confounders of the relationship between prehospital transportation and care and length of hospital stay, and assess aspects of prehospital transportation and care as effect modifiers of the relationship between injury event and length of stay. The objectives of this study are:

1. To describe characteristics of prehospital transportation and care in Sri Lanka
2. To describe characteristics of the injury event and assess injury event characteristics and patient demographics as predictors of ambulance transport to the first health facility
3. Examine whether mode of transport to the first health facility, transport time to first health facility, and medical care prior to arriving at Teaching Hospital Karapitiya modifies the relationship between injury event and length of hospital stay.

The results of this study could aid in furthering the development of an emergency medical system in Sri Lanka.

2. Methods

2.1 Study Design

This study was conducted by researchers at the Duke University Global Health Institute in partnership with researchers at the Faculty of Medicine at University of Ruhuna in Galle, Sri Lanka and is primarily a cross-sectional study with a small longitudinal component that links characteristics of the injury event, prehospital transportation and care with the outcome length of hospital stay. A cross-sectional survey with questions on patient demographics, injury event, prehospital transportation and care was administered to patients admitted to the Victoria Emergency Trauma Center (ETC) of Teaching Hospital Karapitiya in Galle, Sri Lanka. Information on various aspects of patients' medical treatment and hospital discharge details were extracted from the medical records.

2.1.1 Inclusion and Exclusion Criteria

Patients were considered eligible for participation in our study if they were 18 years or older, presented with an externally-caused, acute injury that were severe enough to require overnight inpatient care. Patients were excluded from our study if they were less than 18 years of age, presented with complaints or other medical conditions not caused by an injury event, did not stay overnight in the hospital, or those patients residing in the intensive care unit who were unable to answer the survey questions themselves.

2.2 Setting

Data collection from June 2017 to August 2017 at Teaching Hospital Karapitiya located in Galle, Sri Lanka. Galle is the capital city of the Southern Province and is located about 120 km south of the country's capital, Colombo. The three districts that make up the Southern Province are the Galle, Matara, and Hambantota districts. Galle is a sizable city with a population of about 101,749[40], while the population of the larger Galle district is approximately 1,063,334[40] of which about 93% are literate[41]. The Galle district has a total land area of 1652 square kilometers[42] and is comprised of 19 divisional secretariats with the largest population residing in the Galle Four Gravets divisional secretariat where THK is located. The Matara and Hambantota districts have populations of approximately 814,048 and 599,903 respectively, and each of the three districts have similar proportions of population distributed among the urban, rural and estate sectors[43]. In the Southern province the agricultural and service sectors account for a substantial portion of total employment, and the workforce is overwhelmingly male[43, 44]. Nearly 75% of the people living in the Southern Province have completed secondary school [43] and many households own at least one type of vehicle.

In Sri Lanka, healthcare is predominantly provided by government with the Ministry of Health operating 631 health facilities[45] throughout the country. The private sector accounts for a smaller portion of total hospitals and primarily functions in an outpatient capacity[45, 46]. Within the public hospital network there are three tiers of facilities which include primary, secondary and tertiary care institutions[45, 46]. Maternity homes, central dispensaries, rural and divisional hospitals, peripheral primary care units are primary level institutions that offer a mix of non-specialized inpatient and outpatient services. Secondary care institutions include base hospitals, district general hospitals and provincial level hospitals which have outpatient services as well as general surgery and medical units[45, 46]. Teaching hospitals and provincial general hospitals comprise tertiary level institutions and have all major medical specialties[45, 46]. In addition to the three tiers of facilities, there are specialized hospitals for cancer, mental health, dental, military, police and prison hospitals[46]. THK is the largest tertiary health care facility in the Southern Province with 1560 beds on 54 wards and several specialty units [47], and serves the population of the Southern province and the surrounding areas[45-47].

2.3 Procedures

The strategy for sampling and recruiting subjects from the target population was similar to methods used in previous studies on prehospital surveillance in resource-limited settings [27, 48-50]. Data collection for our study was hospital-based, with as much of the data collection process being incorporated in to standard care as possible thus minimizing the disruptions to the doctor's ability to provide care[27, 48-50]. Each day of data collection, the research assistants would obtain a list of eligible patients from the emergency trauma center and short stay ward registries. After obtaining the list of eligible patients, eligible participants were approached individually and given more information about our study. At this time if informed consent was obtained, the research assistant would administer the paper survey. Patients for which the severity of their condition prevented from giving consent or answering the questions were not approached about participation in our study. Medical records of participants were scanned daily for relevant information regarding their injury and medical treatment.

2.3.1 Ethics Approval

This study received approval from both the Ethics Review Committee at University of Ruhuna, Faculty of Medicine in Sri Lanka and the Duke University Institutional Review Board. Documents included in the submission were the informed consent form, questionnaire, and IRB protocol.

2.4 Measures

Our primary method of data collection was through a questionnaire administered by research assistants who were recent graduates of the local medical school and were fluent in Sinhalese (local language) and English. The questionnaire was developed through combining the WHO Injury Surveillance form, Surgeons OverSeas Assessment of Surgical Need Version 3.0, and two other studies that had similar objectives but were conducted in different settings [27, 51-53]. Survey questions were adapted to the local context after input from local physicians as well as a doctoral student. Following completion of the survey, it was translated to Sinhalese. There were five components to the questionnaire which included: patient demographics, injury event, traffic injury only, prehospital transportation and care, and a data collection form. The first four sections were completed via a brief interview of the patient, while the data collection form was completed by extracting information from the medical records on injury characteristics, body part injured, medications, surgeries, medical imaging, hospital wards where patient resided, and length of hospital stay.

2.4.1 Variables

The four categories of variables in this study include prehospital transportation and care, covariates, injury event, and the outcome length of stay.

2.4.4.1 Prehospital Transportation and Care

Variables in this category include whether there was a delay in seeking care, time of delay in seeking care, wait time for transport to a health facility, mode of transport to a health facility, transport time, whether patient received medical care before arriving at THK, location and nature of prior medical care, person who administered care, number of stages in prehospital trip, traveled alone or with someone, and cost of transport to the hospital. Delay in seeking care was classified into two groups: those who sought care within one hour of the injury event and those who waited longer than one hour to seek care. Waited for transport was coded as a binary variable and was defined as once a person decided to seek care at a hospital for their injury whether they had to wait for transportation to the hospital. Prior medical care and proxy were both coded as binary (yes/no) variables. Mode of transport was a categorical variable with many options including pedestrian, tuk-tuk, motorbike, car, van, ambulance, truck, bus, or other. Mode of transport was combined into four categories (tuk-tuk, car or van, ambulance, other) for analysis purposes. Transport time was measured in hours and minutes. The number of stages in the prehospital trip was obtained. The number of stages ranged from one to three. Stage one was defined as injury site (origin) to first health facility (end), and people that came directly to THK from the injury site were marked as having one stage in their trip to THK. Stage two was defined as the first health facility patient arrived at (origin) to second health facility (end). People that went to one hospital and then came to THK were marked as having two stages in their prehospital trip. People that went to two hospitals before THK were marked as having three stages in their prehospital trip. For each segment of the prehospital trip, mode of transport, transport time, origin and end location were recorded.

For one part of the analysis prehospital and transport variables were evaluated as outcome variables with patient demographics and injury event characteristics serving as the predictor variables (Figure 1).

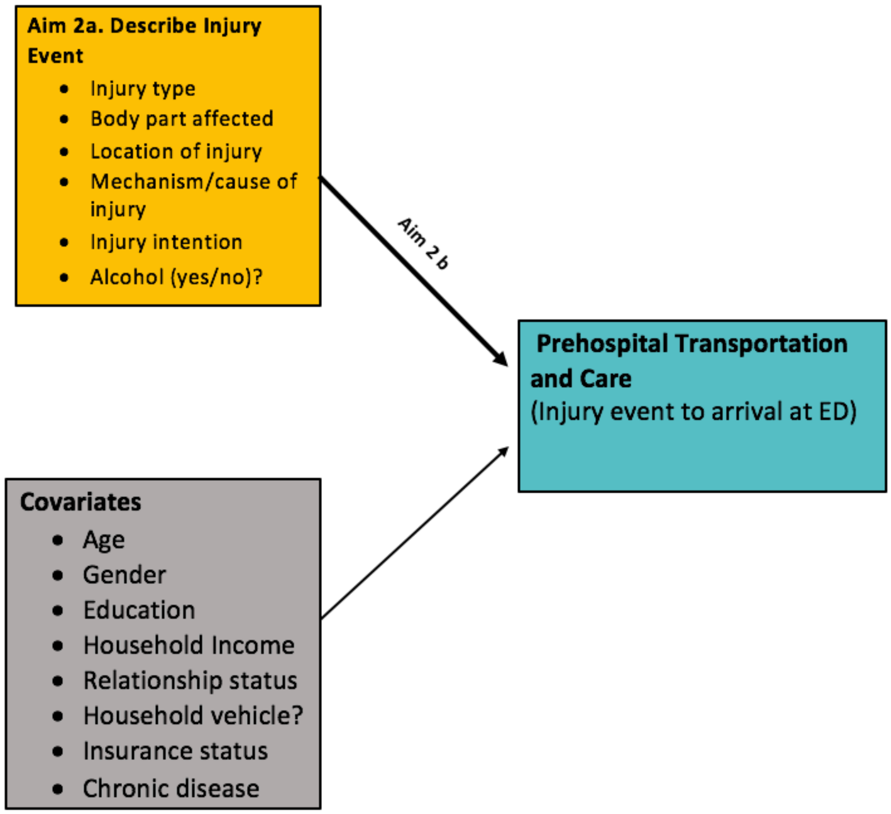

Figure 1: Diagram depicting aim 2 of the study where injury event and covariates were evaluated as predictors of prehospital transportation and care variables (outcomes)

In a different part of the analysis the prehospital transportation and care variables were evaluated as predictors of length of stay and effect modifiers of the relationship between injury event and length of hospital stay (Figure 2).

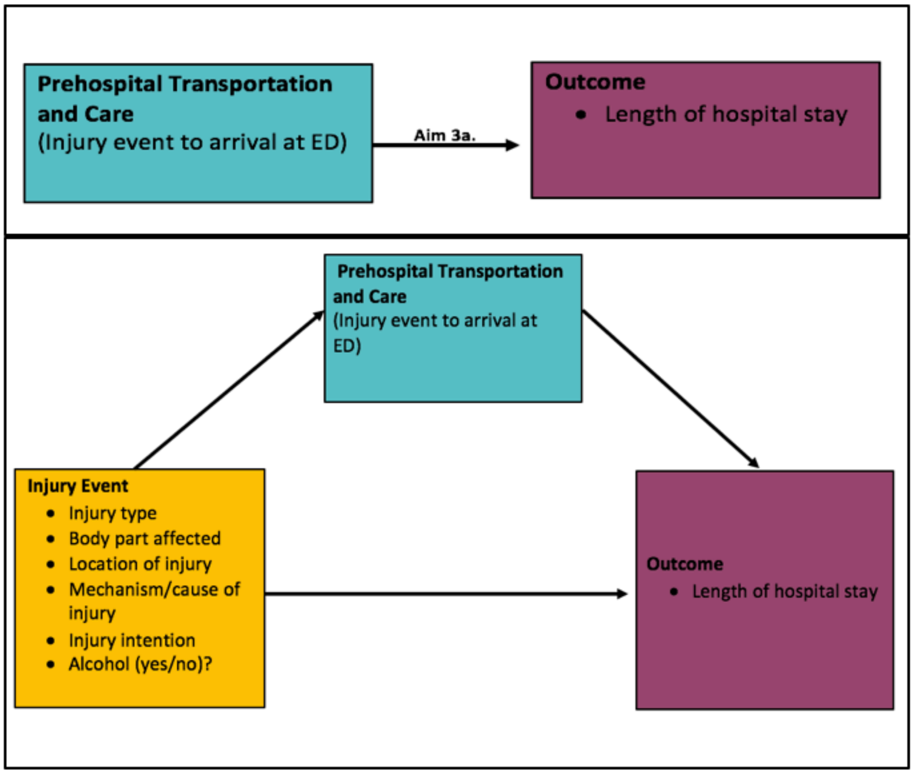

Figure 2: Conceptual diagram depicting PH transportation and care variables as predictors (top) and effect modifiers of length of stay (bottom)

2.4.4.2 Patient Demographics

Specific demographics that were measured include age, gender, education level, relationship status, job, monthly household income in Sri Lankan Rupees, household vehicle, supplemental health insurance, and chronic diseases. Age was examined as both a continuous and categorical predictor variable. For categorical age, three age groups (18 to 39, 40 to 55, 56 to 95) were created. Education level, relationship status, and job were nominal variables with three or more categories each. Monthly income in rupees (~155 rupees to 1 USD) was divided into the following categories: <=45,000 and >45,000 rupees.

The presence of chronic diseases was a binary variable, and for those patients who had a chronic disease it was further classified as one chronic disease or 2+ diseases.

2.4.4.3 Injury Event and Injury Type Variables

Type of location, cause of injury, injury intent, and alcohol use within six hours of the injury event were categorical variables. Type of location was tabulated into five categories: home, work, street, market, and other. Common causes of injury were road traffic injury, falls, stab or cuts, other blunt force, and other. Other blunt force category consisted of people who were injured by a heavy weight falling on some part of the body or those who were assaulted with a blunt object. Injury intent was reported as unintentional, self-harm, or intentional (assault). Self-report alcohol use was a binary variable. There were two variables specific to road traffic injury: mode of travel (bicycle, motorbike, tuk-tuk, bus, car) when injured and then road user type (pedestrian, driver/vehicle operator, passenger). The approximate location or address of the injury event was obtained and geocoded for spatial analysis purposes.

Injury type and body part injured are not mutually exclusive and were coded as binary indicator variables. Indicator variables for injury type included fracture, laceration, open wound, bleeding, burn, abrasion, dislocation, traumatic brain injury, cut, organ system injury, and contusion. Body part injured was classified into head/face, neck, upper limb, spine, and lower limb.

2.4.4.4 Outcome Variable

The primary dependent variable of interest was length of hospital stay measured in days. Length of stay was treated as a count variable in the analysis. Use of an ambulance to first health facility (stage 1 ambulance) was coded as a binary variable and was treated as an outcome when examining subject characteristics, injury event, injury type, and body part injured as predictors of ambulance use.

2.5 Data Management and Analysis

2.5.1 Data Preparation and Descriptive Statistics

Data was collected and then entered into a password protected electronic database using REDCap [54]. Following initial data entry, surveys were checked a second time for any errors that occurred during the original entry. Data analysis was carried out using Microsoft Excel (Microsoft Corp, Washington), Stata 15.0 (College Station, TX), and ArcGIS Pro (Esri, California). After the data was imported into Stata, some of the data needed to be coded and cleaned for analysis purposes. Free-text fields were characterized into categorical variables, and for any time variables the hours and minutes variables were combined into minutes to obtain summary statistics. Variables with four or more categories were condensed into fewer categories and indicator variables were created for all nominal variables with three or more categories. Age and income were converted from continuous to categorical variables as they were not expected to be linearly related to our outcome variables. Proportions and frequencies were used to describe the study sample as well as the injury event, and any categorical prehospital transportation and care variables. Means and standard deviations were used to summarize continuous variables. Cross tabulations were done and row percentages were calculated to examine relationships between patient demographics and prehospital transportation and care, as well as relationships between injury event characteristics and prehospital transportation and care variables.

2.5.2 Negative Binomial Regression Models

Patient demographics, injury event characteristics, injury type, body part injured, and prehospital transportation and care were examined as predictors of length of hospital stay using a negative binomial regression. Negative binomial models were used because the dependent variable (length of stay) is a count variable and this model accounts for over dispersion in the dependent variable which occurs when the variance is greater than the mean. The coefficients in all negative binomial models were exponentiated to obtain incidence rate ratios. Separate models were created for individual predictor variables to examine whether they had a significant effect on length of stay. Significance was established as $p<0.1$. Any individual predictors where $p<0.1$ were later entered in to a multivariable negative binomial regression model. Several multivariable models were created to examine the effect various groups of variables (prehospital transportation and care, injury event, body part injured, demographics) on length of stay. The first multivariable model examined stage 1 mode and medical care prior to arriving at THK as predictors of length of stay. The second model added injury mechanism, injury intent, injury type, and body part injured in addition to the variables in the first multivariable model. The full model also contained job and monthly household income as predictors of length of stay in addition to the variables in the first two models. With significance set at $p<0.1$, a backwards stepwise elimination strategy was used to eliminate variables one at a time until the final model was obtained.

A negative binomial regression model with interaction terms was used to examine stage 1 transport time, stage 1 mode of transport, and medical care prior to arriving at THK as potential effect modifiers of the relationship between injury event and length of hospital stay. Exposures in the fully specified interaction model were spinal injury, open wound, and fracture with stage 1 transport time, stage 1 mode of transport and prior medical care serving as effect modifiers of the injury event and length of hospital stay relationship.

2.5.3 Logistic Regression Models

To determine what factors were associated with whether there was a delay in seeking care, whether a patient received medical care before arriving at THK, and whether a patient used an ambulance to get to the first health facility a series of logistic regression models were created with patient demographics, injury event and injury characteristics, as well as body part injured serving as predictor variables. The coefficients in all logistic regression models were exponentiated to obtain odds ratios.

For bivariate models significance was set at $p<0.1$. Multivariable models were created to examine whether patient demographics and injury event characteristics were significantly associated with medical care prior to arriving at THK and whether a patient used an ambulance to get to the first health facility. Two multivariable models were created for the outcome of stage 1 ambulance.

2.5.4 GIS Spatial Analysis

Location of each injury event was geocoded to obtain the longitude and latitude coordinates. Injury coordinates and attributes were imported into ArcGIS Pro to determine if there were any spatial patterns for stage 1 mode, prior care, injury event and injury mechanism variables.

3. Results

3.1 Description of the Study Sample

Data collection lasted for two months, beginning on June 9th, 2017 and ending on August 10th, 2017. During this time, 405 participants that were admitted to the emergency trauma center of THK were recruited to be participate in our study. Demographic characteristics of study participants are presented in Table 1. Over half of the study population was male (58.3%), and the average age of participants was 44.5±17.2 with youngest participant being 18 and the oldest was 95 years old. Nearly three quarters of the sample had completed at least some secondary education, and 24.9% of the sample had completed the highest level of secondary education in Sri Lanka (senior secondary GCE AL). More people worked at an inside desk job or were a shop worker (23.7%) than any other reported job type. In this study, 19.3% of people reported that they were unemployed. Average monthly household income was 40,340.8±19,858.12 Sri Lankan Rupees (~155 LKR to 1 USD). Most people in this study were married (72.4%), and almost 80% of people reported that their household owned a vehicle. More people owned a motorbike than any other type of vehicle, while some households owned more than one vehicle. Approximately 25% of the sample reported having a chronic disease. Common diseases reported include type 2 diabetes, ischemic heart disease, dyslipidemia.

Table 1: Characteristics of Study Participants

Variable	Frequency	(%)
Gender		
Male	236	58.3%
Female	169	41.7%
Age (in years)		
18 to 39	191	47.2%
40 to 55	111	27.4%
56 to 95	103	25.4%
Education		
No School	26	6.4%
Primary	24	5.9%
Jr. Secondary	47	11.6%
Sr. Secondary	151	37.3%
Sr. Secondary GCE AL	101	24.9%
Univ. Undergraduate	20	4.9%
Postgraduate	31	7.7%
Vocational/Technical	4	1.0%
Missing	1	0.3%
Job		
Housewife	43	10.7%
Outside/Manual Labor	79	19.5%
Teacher/Student	46	11.4%
Inside desk Job/ Shop Worker	96	23.7%
Factory worker/Mechanic	14	3.5%
Driver	15	3.7%
Hospitality	11	2.7%
Government Worker	8	2.0%
Self-employed	15	3.7%
Unemployed	78	19.3%
Monthly Income (Rupees)		
<=45,000	279	68.9%
>45,000	126	31.1%
Relationship Status		
Single	72	17.8%
Married	293	72.4%
Divorced	2	0.5%
Widowed	38	9.4%

Household Vehicle		
Bicycle	21	5.2%
Motorbike	192	47.4%
Tuk-tuk	84	20.7%
Car	58	14.3%
Supplemental Health Insurance		
Yes	82	20.2%
Missing	1	0.3%
Chronic Disease		
Yes	102	25.2%
# of Chronic Diseases		
1	74	18.3%
2 or more	28	6.9%

3.1.1 Injury Event and Injury Type Characteristics

Characteristics of the injury event as well as prehospital transportation and care are outlined in Table 2.

Table 2: Injury Event Characteristics: Frequencies and Proportions

Variable	Frequency	% of sample (n=405)
Injury Event		
RTI	168	41.5%
Falls	116	28.6%
Stab or Cut	45	11.1%
Other Blunt Force	57	14.1%
Other	19	4.7%
Injury Intention		
Unintentional	350	86.4%
Self-harm	4	1.0%
Assault	51	12.6%
Location Type		
Home	143	35.3%
Work	48	11.9%
Street	180	44.4%
Market	10	2.5%
Other	24	5.9%

Alcohol w/in 6 hrs of Injury		
No	331	81.7%
Yes	74	18.3%
Prehospital Transportation and Care Variables		
>1 hr Delay in Seeking Care		
No	345	85.2%
Yes	60	14.8%
Waited for Transport		
No	348	85.9%
Yes	57	14.1%
Paid for Transport		
No	308	76.1%
Yes (Mean=556 LKR)	94	23.2%
Missing	3	0.7%
Prior Medical Care		
No	171	47.2%
Yes	234	57.8%
# of Stages of PH Trip		
1	233	57.5%
2	156	38.5%
3	16	4.0%
Transport Time by Stage (min)	**Mean**	**SD**
1	27	18.3
2	55	41.1
3	72	38.3

The most common injury mechanism reported was road traffic injury (41.5%) followed by falls (28.6%). Other mechanisms of injury include assault with a blunt object, heavy weight falling on the body, stab or cut, burns, drowning, electric shock, and animal bites. Almost 45% of the study sample was in the street when they were injured, and over 33% of participants were at home when the injury occurred. Most the injuries were unintentional (86.4%), and intentional assaults accounted for 12.6% of injuries in this study. Self-harm accounted for less than 1% of injuries. Alcohol use within six hours of the injury event was reported by 18.3% of participants. Nearly 67% of people injured in a road traffic incident were traveling on a motorbike when they were injured and approximately 67% of people injured on a motorbike were operating the vehicle.

Injury type and body part injured characteristics are presented in Table 3. Fracture was the most common injury type in this study sample, affecting 228 participants (56.3%), followed by lacerations affecting 165 people (40.7%) and bleeding affected 82 people (20.3%).

Table 3: Injury Type and Body Part Injured: Frequencies and Proportions

Variable	Frequency	% of Sample (n=405)
Injury Type		
Fracture	228	56.3%
Open Wound	50	12.4%
Cut	40	9.9%
Laceration	165	40.7%
Concussion/TBI	14	3.5%
Bleeding	82	20.3%
Abrasion	66	16.3%
Dislocation	30	7.4%
Contusion	22	5.4%
Other	38	9.4%
Body Part Injured		
Head/Face	122	30.1%
Neck	11	2.7%
Upper Limb	164	40.5%
Chest/Abdomen	39	9.6%
Spine	24	5.9%
Lower Limb	194	47.9%

Most people only had one body part injured (58.8%), and of those who had more than one body part injured the mean number of body parts injured was 2.6. The maximum number of parts injured was six. Almost half the participants in this study had a lower limb injury (47.9%), while only 11 people (2.7%) had a neck injury. In this study sample, upper limb was the second most common body part injured with about 40% of the study population affected by an upper limb injury.

3.1.2 Descriptive Statistics of Prehospital Transportation and Care Variables

To accomplish the first aim of this study, descriptive statistics were calculated for each prehospital transportation and care variable. Approximately 15% of people in this study sample waited longer than one hour to seek medical care, and 14% of people had to wait for transport to take them to a health facility. Mean transport time from injury site to the first health facility (Stage 1) was 27.1±18.3 minutes. Travel time increased in each stage, with average transport time of stages 2 and 3 being 55.4±41.1 and 71.9±38.3 minutes respectively. Mode of transport by stage of prehospital trip is depicted in Figure 3. Stage 1 refers to injury site to first health facility (n=233). Stage 2 (n=156) refers to first health facility (end of stage 1) to second health facility (end) which could have been THK or another hospital. Stage 3 (n=16) refers to second health facility from end of stage 2 (orgin) to THK (end). No person in the study stopped at more than two hospitals before arriving at THK.

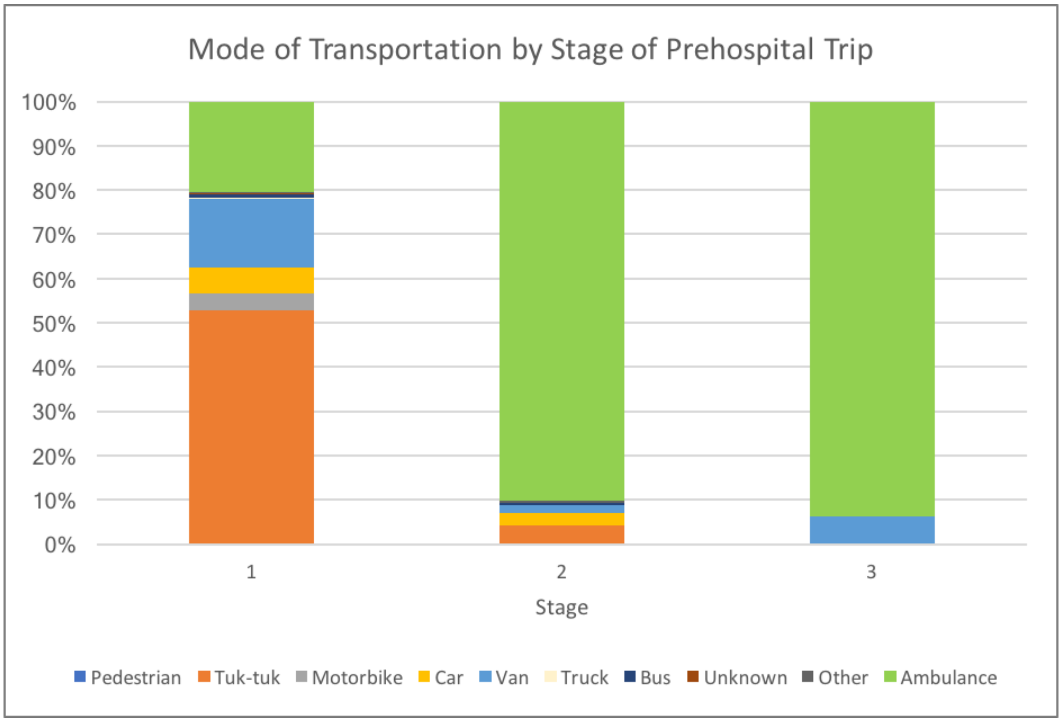

Figure 3: Mode of transportation by stage of prehospital trip.

The top three modes of transportation used to get to the first health facility were tuk-tuk, car or van, and ambulance. 20.5% of people used an ambulance to get from the injury site to the first health facility. For stages two and three, ambulances are used almost exclusively for transfer of patients between hospitals (Figure 3). Less than 25% of people paid for transport to the hospital, and of those who paid, the average amount paid was 556 rupees. Over 90% of people in this study had someone travel to the hospital with them.

Information on prehospital care is summarized in Table 4. 233 people in this study (57.5%) traveled directly from the injury site to THK, while 156 (38.5%) went to another health facility before arriving at THK.

Table 4: Nature of Medical Care Administered Prior to Arriving at THK

Variable	Frequency	% of sample (n=405)
Location of Care		
At site of injury	19	4.7%
While traveling to Hospital	44	10.9%
Non-specialist Hospital	75	18.5%
Base Hospital	71	17.5%
District General Hospital	31	7.7%
Private Health Facility	12	3.0%
Person who Administered Care		
Nurse	106	26.2%
Trained Lay Responder	12	3.0%
Bystander	2	0.5%
Family Member	11	2.7%
Friend	3	0.7%
Doctor	158	39.0%
Unknown	1	0.3%
Nature of Care		
Painkillers	92	22.7%
Diagnostics	22	5.4%
Stabilization	116	28.7%
IV	35	8.6%
Wound Clean & Dress	68	16.8%
Other Medications	46	11.4%
Suturing	22	5.4%
Oxygen	21	5.2%

Only 4% of the study population went to two health facilities before coming to THK. 57.6% of people received care before they arrived at THK (Table 2). Of people who received care prior to arriving at THK, most received their care at a non-specialist

(18.5%) or base hospital (17.5%). Fewer people received care at the injury site or while traveling to the hospital, and most care was administered by trained doctors or nurses. Nature of prehospital care ranged from a family member cleaning and dressing an open wound to a trained doctor stabilizing a fracture at a district general hospital. 39.3% of people who received medical care before THK were administered painkillers and 21 people received oxygen.

3.2 Negative Binomial Regression Model Results

To achieve aim three of this study, a series of negative binomial regression models were created. The dependent variable in this set of models was length of hospital stay measured in days. Average length of stay for the study sample was 5.4±4.7 days. The first set of models contained one predictor variable each, and examined the association between subject characteristics, prehospital transportation and care, injury event, injury type, body part injured, and length of stay. The second set of models pulled predictor variables from the bivariate models where $p<0.1$ and were entered in to multivariable models. The coefficients in each model were exponentiated to obtain incidence rate ratios. Results of negative binomial regression models with one predictor variable are outlined in Tables 5-8.

3.2.1 Models with one Predictor variable

Monthly household income and outside/manual labor job type were significantly associated with length of hospital stay ($p<0.05$). People in the higher income bracket had length of stays that were 20.4% shorter (0.796, 95% CI 0.661-0.958) than those in the lower income bracket. The average length of stay for people who had outside, manual labor jobs was 37% longer (1.370, 95% CI 1.093- 1.719) than those people who worked at an inside desk job. Gender was trending towards significance (p<0.1) and was included in the multivariable model. Length of stay for females was 15% shorter (0.850, 95% CI 0.896-1.361) when compared to males.

Table 5: Subject Characteristics as Predictors of Length of Stay using Bivariate Negative Binomial Regression

	Length of Hospital Stay	
Variable	**IRR (95% CI)**	**P-value**
Age (continuous)	1.003 (0.998, 1.008)	0.203
Intercept	4.705 (3.710, 5.966)	-
Age Categorical (years)		
18-39 , REF	5.293 (4.672, 5.997)	-
40-55	1.002 (0.816, 1.232)	0.981
56-95	1.104 (0.896, 1.361)	0.354
Gender		
Male, REF	5.801 (5.192, 6.481)	-
Female	0.850 (0.714, 1.011)	0.066
Income		
<=45,000, REF	7.299 (5.560, 9.429)	-
>45,000	0.796 (0.661, 0.958)	0.016*
Relationship		
Married, REF	5.570 (5.040, 6.156)	-
Single	0.823 (0.654, 1.035)	0.096
Divorced/Widowed	1.077 (0.809, 1.434)	0.611
Education		
Grades 1-13, REF	5.533 (5.028, 6.087)	-
No School	1.050 (0.741, 1.487)	0.785
Vocational/Technical	0.904 (0.377, 2.168)	0.821
University/Postgraduate	0.843 (0.648, 1.098)	0.206

Job		
Inside Desk/Shop Worker, REF	4.739 (4.097, 5.483)	-
Housewife	1.227 (0.912, 1.650)	0.177
Outside/Manual Labor	1.370 (1.093, 1.719)	0.006*
Other	1.102 (0.829, 1.466)	0.503
Unemployed	1.133 (0.890, 1.444)	0.311
Chronic Disease		
1, REF	5.108 (4.180, 6.243)	-
2 or more	1.224 (0.840, 1.783)	0.294

Stage 1 mode of transport, medical care prior to arrival at THK, and many of the nature of prehospital care were significantly associated with length of stay in models where various prehospital transportation and care variables were evaluated as predictors of length of stay (Table 6). People that received care prior to arrival at THK had length of stays that were approximately 22% longer than those who did not receive medical care. For people who used other stage 1 mode of transport (bus, tractor, pedestrian, or truck) to get to the first health facility, their hospital stays were about 53% shorter than those who used a tuk-tuk. Painkillers, stabilize (ex. splinting a limb), and prehospital administration of intravenous fluids were significantly associated with length of stay at THK.

Table 6: Prehospital Transportation and Care as Predictors of Length of Stay using Bivariate Negative Binomial Regression

	Length of Hospital Stay (Days)	
Variable	**IRR (95% CI)**	**P-Value**
>1 hr Delay in Seeking Care		
< 1 hr Delay, REF	5.487 (5.002, 6.019)	-
> 1 hr Delay	0.939 (0.737, 1.196)	0.608

Waited for Transport to Hosp.		
No, REF	5.376 (4.902, 5.897)	-
Yes	1.080 (0.846, 1.379)	0.537
Stage 1 Mode		
Tuk-tuk, REF	5.469 (4.868, 6.145)	-
Car or Van	1.030 (0.830, 1.278)	0.790
Ambulance	1.064 (0.855, 1.324)	0.579
Other	0.470 (0.304, 0.726)	0.001**
Stage 1 Travel Time	0.999 (0.994, 1.003)	0.560
Intercept	5.658 (4.871, 6.573)	-
Stage 2 Travel Time	1.002 (0.999, 1.005)	0.165
Intercept	5.657 (4.586, 6.976)	-
Stage 3 Travel Time	1.002 (0.997, 1.008)	0.397
Intercept	7.879 (4.917, 12.624)	-
Medical Care before THK		
No, REF	4.830 (4.229, 5.517)	-
Yes	1.217 (1.024, 1.447)	0.026*
Nature of Care		
No Painkillers, REF	5.147 (4.669, 5.674)	-
Painkillers	1.248 (1.021, 1.525)	0.030*
No Diagnostics, REF	5.319 (4.871, 5.807)	-
Diagnostics	1.410 (0.980, 2.030)	0.064
No Stabilize, REF	4.765 (4.308, 5.270)	-
Stabilize	1.493 (1.244, 1.791)	<0.001**
No IV, REF	5.214 (4.769, 5.700)	-
IV	1.496 (1.118, 2.003)	0.007*
No Oxygen, REF	5.385 (4.932, 5.880)	-
Oxygen	1.185 (0.811, 1.731)	0.381
Paid for Transport		
No, REF	5.414 (4.968, 5.901)	-
Yes	1.004 (0.994, 1.013)	0.448

Stab or cut, other blunt force, and other injury mechanisms all had significantly shorter length of stays than those who were injured in a road traffic incident ($p<0.05$). Hospital stays of people injured by a stab or cut were 31% shorter, with people injured by other mechanism having stays that were 43% shorter than those injured in a RTI

(Table 7). Self-harm injuries had 64% shorter stays (0.360, 95% CI 0.129-1.002) than those of unintentional injuries (p<0.05).

Table 7: Injury Event Characteristics as Predictors of Length of Hospital Stay using Bivariate Negative Binomial Regression

	Length of Hospital Stay	
Variables	IRR (95% CI)	P-Value
Injury Mechanism		
RTI, REF	5.804 (5.108, 6.594)	-
Fall	1.144 (0.938, 1.394)	0.184
Stab/Cut	0.693 (0.519, 0.926)	0.013*
Other Blunt Force	0.644 (0.493, 0.840)	0.001**
Other	0.571 (0.371, 0.880)	0.011*
Intent of Injury		
Unintentional, REF	5.554 (5.069, 6.086)	-
Self-harm	0.360 (0.129, 1.002)	0.050*
Intentional (Assault)	0.883 (0.681, 1.144)	0.346
Alcohol		
No, REF	5.420 (4.930, 5.958)	-
Yes	1.017 (0.815, 1.269)	0.879
Location Type		
Street, REF	5.600 (4.928, 6.364)	-
Home	0.928 (0.765, 1.125)	0.447
Work	1.027 (0.778, 1.356)	0.852
Market	0.911(0.519, 1.599)	0.745
Other	0.923 (0.634, 1.344)	0.674

Injury types that were significantly associated with longer hospital stays were fracture, open wound and injury types that were associated with shorter stays included cut, laceration, and contusions (Table 8). The hospital stays of people with fracture were about 2.5 times longer (2.461, 95% CI 2.098-2.888) than those who did not have fractures. 57% shorter hospital stays were reported for those with contusion injuries (0.429, 95% CI

0.281-0.655) compared to those without contusion injuries. Spine and lower limb injuries were linked to longer hospital stays, while chest or abdomen and head or face injuries were correlated with shorter hospital stays. The hospital stays of people with spine and lower limb injuries were 45% longer (1.456, 95% CI 1.028-2.063) and 70% longer (1.700, 95% CI 1.442-2.005) respectively. For people with head or face injuries had hospital stays that were approximately 33% shorter (0.671, 95% CI 0.556-0.809) than those without a head injury, while those with a chest or abdomen injury had hospital stays that were 28.4% shorter (0.716, 95% CI 0.530-0.965) than people who did not have a chest or abdomen injury.

Table 8: Injury Type and Body Part Injured as Predictors of Length of Hospital Stay using Bivariate Negative Binomial Regression

	Length of Hospital Stay	
Variables	**IRR (95% CI)**	**P-Value**
Injury Type		
Fracture	2.461 (2.098, 2.888)	<0.001**
No Fracture, REF	2.983 (2.626, 3.389)	-
Open Wound	1.624 (1.270, 2.078)	<0.001**
No Open Wound, REF	5.048 (4.611, 5.526)	-
Cut	0.691 (0.513, 0.930)	0.015*
No Cut, REF	5.608 (5.129, 6.132)	-
Laceration	0.688 (0.579, 0.818)	<0.001**
No Laceration, REF	6.229 (5.596, 6.934)	-
Concussion/TBI	1.152 (0.714, 1.858)	0.563
No Concussion/TBI, REF	5.411(4.960, 5.903)	-
Bleeding	1.092 (0.884, 1.349)	0.414
No Bleeding, REF	5.337 (4.849, 5.875)	-
Abrasion	0.820 (0.648, 1.037)	0.097
No Abrasion, REF	5.602 (5.105, 6.147)	-

Dislocation	0.940 (0.676, 1.306)	0.712
No Dislocation, REF	5.461 (4.997, 5.969)	-
Contusion	0.429 (0.281, 0.655)	<0.001**
No Contusion, REF	5.611 (5.147, 6.117)	-
Other	1.559 (0.968, 2.513)	0.068
No Other, REF	2.476 (1.673, 3.664)	-
Body Part Injured		
Head/Face	0.671 (0.556, 0.809)	<0.001**
No Head/Face Inj., REF	6.035 (5.466, 6.665)	-
Neck	1.491 (0.900, 2.471)	0.121
No Neck Inj., REF	5.365 (4.920, 5.851)	-
Upper Limb	0.850 (0.714, 1.012)	0.068
No Upper Limb Inj., REF	5.788 (5.187, 5.460)	-
Chest/Abdomen	0.716 (0.530, 0.965)	0.029*
No Chest/Abdomen Inj., REF	5.590 (5.113, 6.112)	-
Spine	1.456 (1.028, 2.063)	0.034*
No Spine Injury, REF	5.294 (4.848, 5.781)	-
Lower Limb	1.700 (1.442, 2.005)	<0.001**
No Lower Limb Inj., REF	4.071 (3.618, 4.582)	-

3.2.2 Multivariable Negative Binomial Model Results

Results from all multivariable negative binomial models are presented in Table 9. In the first model, for stage 1 mode, other transport type (0.476, 95% CI 0.309-0.734) and prior medical treatment (1.21, 95% CI 1.015-1.447) are significantly associated with length of stay. The hospital stays of those who used 'other' stage 1 mode were approximately 52% shorter (0.48, 95% CI 0.31-0.73) than those who used a tuk-tuk, when accounting for prior medical care. However, in the second and the fully specified models, stage 1 mode does not significantly predict length of stay when adjusting for prior medical treatment, injury mechanism, injury type, and body part injured. Open wound (2.50, 95% CI 1.42-4.41) and spine injuries (3.01, 95% 1.01-8.99), as well as prior medical care (2.01, 95% CI 1.29-3.14) remained significant predictors of length of stay in the fully specified model.

Backwards elimination, with significance set at p<0.1, was used to obtain the final model containing predictors of length of stay. Variables that remained in the model were stage 1 mode (car/van & ambulance), medical care before arriving at THK, open wound, upper limb and spine injuries. In this model, people with spine injuries had length of stay that were 3.8 times (3.84, 95% CI 1.69-8.73) as long as those without spine injuries, while people that took a car or van to the first health facility had length of stays that were about 38% shorter (0.62, 95% CI 0.40-0.97) than those that used a tuk-tuk to get to the first health facility.

Table 9: Predictors of Length of Stay using Multivariable Negative Binomial Regression

	IRR (95% CI)		IRR (95% CI)		IRR (95% CI)		IRR (95% CI)
Model Intercept	4.910 (4.220, 5.712)[a]		3.026 (0.303, 30.252)[b]		1.606 (0.103, 24.983)[c]		1.339 (0.931, 1.925)[d]
Stage 1 Mode							
Car or Van	1.041 (0.840, 1.291)	0.715	0.702 (0.412, 1.196)	0.193	0.748 (0.423, 1.325)	0.320	0.624 (0.402, 0.969)
Ambulance	1.011 (0.809, 1.263)	0.926	1.333 (0.798, 2.227)	0.272	1.403 (0.836, 2.355)	0.199	1.710 (1.169, 2.503)
Other	0.476 (0.309, 0.734)	0.001**	2.432 (0.521, 11.350)	0.258	2.243 (0.441, 11.401)	0.330	
Med. Care Before THK							
Yes	1.212 (1.015, 1.447)	0.033*	1.979 (1.271, 3.082)	0.003*	2.008 (1.286, 3.135)	0.002*	1.947 (1.353, 2.801)
Injury Mechanism							
Fall			1.535 (0.758, 3.110)	0.234	1.666 (0.749, 3.703)	0.211	
Stab/Cut			1.504 (0.437, 5.180)	0.517	1.687 (0.463, 6.146)	0.428	
Other Blunt Force			1.022 (0.530, 1.969)	0.949	1.267 (0.570, 2.817)	0.561	
Other			1.609 (0.736, 3.517)	0.233	1.785 (0.667, 4.774)	0.249	
Injury Intent							
Self-harm			0.411 (0.045, 3.726)	0.429	0.426 (0.045, 4.084)	0.460	
Intentional (Assault)			0.875 (0.450, 1.701)	0.694	0.771 (0.392, 1.520)	0.453	
Injury Type							
Fracture			1.490 (0.600, 3.697)	0.390	1.710 (0.604, 4.842)	0.312	
Open Wound			2.282 (1.357, 3.839)	0.002*	2.502 (1.420, 4.407)	0.002*	2.523 (1.600, 3.977)
Cut			1.344 (0.390, 4.633)	0.640	1.553 (0.434, 5.557)	0.498	
Laceration			1.023 (0.596, 1.758)	0.933	1.171 (0.646, 2.125)	0.603	
Abrasion			1.614 (0.915, 2.847)	0.098	1.725 (0.921, 3.231)	0.089	
Contusion			0.252 (0.028, 2.256)	0.218	0.337 (0.035, 3.212)	0.345	
Other Injury Type			0.268 (0.032, 2.207)	0.221	0.378 (0.043, 3.316)	0.380	
Body Part Injured							
Head/Face			1.204 (0.697, 2.080)	0.505	1.218 (0.701, 2.118)	0.484	
Chest/Abdomen			1.263 (0.732, 2.179)	0.402	1.262 (0.715, 2.229)	0.422	
Upper Limb			1.872 (1.103, 3.178)	0.020*	1.643 (0.912, 2.960)	0.098	1.865 (1.325, 2.625)
Spine			4.063 (1.456, 11.336)	0.007*	3.007 (1.006, 8.994)	0.049*	3.837 (1.686, 8.732)
Lower Limb			0.979 (0.626, 1.531)	0.346	0.909 (0.563, 1.470)	0.698	

Job		
Housewife	1.262 (0.525, 3.034)	0.603
Outside/Manual	1.236 (0.636, 2.401)	0.532
Labor	1.509 (0.758, 3.002)	0.241
Other	1.711 (0.934, 3.137)	0.082
Unemployed		
Income		
>45,000	0.957 (0.567, 1.615)	0.869

[a]Model 1, in the first column, contained stage 1 mode and prior medical treatment as predictor variables

[b]Model 2, in the second column, contained all variables in model 1 and added injury mechanism, injury intent, injury type, and body part injured

[c]Model 3, in the third column, contained all variables in model 2, and added job as well as monthly household income. It contains all predictors of length of stay from bivariate models where p<0.1

[d]Model 4, in the fourth column, was obtained using backwards elimination strategy with significance set at p<0.1 and contains upper limb injury, spine injury, open wound, prior medical care, and stage 1 mode (car/van & ambulance) as final predictor variables

3.2.2.1 Evaluating Stage 1 mode, Prior Medical Care, and stage 1 transport time as effect modifiers of the relationship between Injury characteristics and length of hospital stay

In this model, stage 1 mode, medical care before arrival at THK, and stage 1 transport time were examined as effect modifiers of the relationship between three exposures (spine injury, open wound, fracture) and length of hospital stay. Stage 1 transport time was coded as a binary variable (<=20min & >20 min). Separate interaction terms were created for each exposure and potential effect modifier. Taken together, open wound and travel time to first health facility of more than 20 minutes significantly predicts length of stay ($p<0.05$). The hospital stays of those with open wound who took an ambulance to the first health facility were 42% shorter (0.58, 95% CI 0.34-0.97) than those with open wounds who used tuk-tuks. The interaction term containing open wound and prior medical treatment was not significant. Stage 1 mode, stage 1 transport time, and prior medical treatment did not significantly affect the relationship between spine injuries and length of hospital stay (Table 10). Only prior medical treatment significantly affected the relationship between fracture and length of stay, with those people who received treatment before THK having 42% shorter (0.58, 95% CI 0.42-0.81) length of stays than those with fractures who did not receive medical care ($p<0.05$).

Table 10: Effect Modifiers of Injury Type and Length of Stay Relationship using Negative Binomial Regression

Variable	IRR (95% CI)
Spine	1.216 (0.650-2.277)
Fracture	2.787 (2.019-3.847)*
Open Wound	1.886 (1.152-3.087)*
Travel time (min)[a]	0.876 (0.677-1.134)
Stage 1 Mode	
Car or Van	1.228 (0.474-1.735)
Ambulance	1.693 (1.006-2.847)
Other	0.452 (0.234-0.874)
Prior Medical Treatment	1.582 (1.215-2.061)*
Spine Injury	
Spine*Transport time	0.907 (0.474-1.735)
Spine*CarorVan	1.791 (0.810-3.961)
Spine*Ambulance	0.882 (0.371-2.095)
Spine*Other	4.574 (0.952-21.986)
Spine*PriorMedTreatment	0.908 (0.468-1.764)
Open Wound	
OpenWound*TransportTime	0.529 (0.335-0.836)*
OpenWound*CarorVan	0.888 (0.502-1.572)
OpenWound*Ambulance	0.578 (0.344-0.970)*
OpenWound*Other	1.739 (0.691-4.377)
OpenWound*PriorMedTreatment	1.303 (0.810-2.094)
Fracture	
Fracture*TransportTime	1.358 (0.986-1.871)
Fracture*CarorVan	1.119 (0.759-1.651)
Fracture*Ambulance	1.159 (0.766-1.754)
Fracture*Other	0.543 (0.232-1.268)
Fracture*PriorMedTreatment	0.583 (0.232-1.268)*

[a]Transport time was coded as a binary variable for this model (<=20 min & >20 min)

[b] * indicates significance ($p<0.05$)

3.3 Logistic Regression Results

3.3.1 Logistic Models with an Outcome of Stage 1 Ambulance

To achieve aim two of this study, a series of logistic regression models were created to identify injury event, injury type, body part injured, and subject characteristics that were significantly associated with using an ambulance to get to the first health facility. The first set of models contained one predictor variable each, and the second set of models contained multiple predictor variables.

3.3.1.1 Models with one predictor variable with Outcome of Stage 1 Ambulance

Age, falls, stab or cut, other blunt force, alcohol use within six hours of the injury event, injured at home, open wound, abrasion, and chest or abdomen injury were all significantly associated with using an ambulance to get to the first health facility. For people in the 56 to 95 age group, the odds of using an ambulance to get to the first health facility were about 58% less than the odds of using an ambulance in the 18 to 39 age group (Table 11).

Table 11: Subject Characteristics as Predictors of Stage 1 Ambulance using Bivariate Logistic Regression

Variables	Stage 1 Ambulance	
	OR (95% CI)	P-Value
Age		
18 to 39, REF	0.345 (0.249, 0.477)	-
40 to 55	0.676 (0.380, 1.202)	0.183
56 to 95	0.419 (0.215, 0.815)	0.010*
Gender		
Male, REF	0.311 (0.231, 0.420)	-
Female	0.611 (0.367, 1.017)	0.058

Income		
<=45,000, REF	0.306 (0.148, 0.632)	-
>45,000	0.877 (0.517, 1.490)	0.628
Relationship		
Married, REF	0.274 (0.207, 0.362)	-
Single	0.961 (0.510, 1.810)	0.901
Divorced/Widowed	0.522 (0.196, 1.386)	0.192
Education		
Grades 1-13, REF	0.272 (0.208, 0.354)	-
No School	0.307 (0.071, 1.330)	0.114
Vocational/Technical	-	-
Univ. Undergrad/Postgrad	1.133 (0.563, 2.280)	0.727
Job		
Inside Desk/Shop Worker, REF	0.303 (0.205, 0.447)	-
Housewife	0.755 (0.319, 1.786)	0.522
Outside/Manual Labor	0.793 (0.416, 1.511)	0.480
Other	0.956 (0.440, 2.077)	0.910
Unemployed	0.661 (0.324, 1.346)	0.253
Chronic Disease		
1, REF	0.156 (0.080, 0.304)	-
2 or more	1.067 (0.305, 3.726)	0.919

Falls, stab or cut, and other blunt force were all associated with lower odds of using an ambulance during stage 1 of the prehospital trip compared to those injured in a RTI, while the odds of using an ambulance for people that were injured by a stab or cut were the lowest (0.28, 95% CI 0.10-0.75). People injured at their home had 74% lower odds of taking an ambulance than those injured in the street (Table 12).

Table 12: Injury Event Characteristics as Predictors of Stage 1 Ambulance using Bivariate Logistic Regression

	Stage 1 Ambulance	
Variables	OR (95% CI)	P-Value
Injury Mechanism		
RTI, REF	0.448 (0.323, 0.622)	-
Fall	0.357 (0.192, 0.664)	0.001**
Stab/Cut	0.279 (0.104, 0.747)	0.011*
Other Blunt Force	0.312 (0.133, 0.735)	0.008*
Other	0.418 (0.117, 1.498)	0.181
Intent of Injury		
Unintentional, REF	0.268 (0.207, 0.347)	-
Self-harm	3.730 (0.517, 26.924)	0.192
Intentional (Assault)	0.593 (0.257, 1.371)	0.222
Alcohol		
No, REF	0.221 (0.167, 0.292)	-
Yes	2.037 (1.156, 3.588)	0.014*
Location Type		
Street, REF	0.452 (0.329, 0.619)	-
Home	0.259 (0.139, 0.483)	<0.001**
Work	0.443 (0.195, 1.008)	0.052
Market	-	-
Other	0.443 (0.145, 1.356)	0.154

Open wound and abrasions were associated with increased odds of using an ambulance, compared to people without those respective injury types (Table 13).

Table 13: Injury Type and Body Part Injured as Predictors of Stage 1 Ambulance using Bivariate Logistic Regression

	Stage 1 Ambulance	
	OR (95% CI)	P-Value
Injury Type		
Fracture	1.226 (0.750, 2.004)	0.417
No Fracture, REF	0.229 (0.157, 0.335)	-
Open Wound	2.256 (1.185, 4.292)	0.013*
No Open Wound, REF	0.228 (0.175, 0.298)	-
Cut	0.526 (0.199, 1.386)	0.194
No Cut, REF	0.272 (0.212, 0.349)	-
Laceration	1.077 (0.660, 1.757)	0.767
No Laceration, REF	0.250 (0.182, 0.343)	-
Concussion/TBI	1.761 (0.529, 5.866)	0.357
No Concussion/TBI, REF	0.252 (0.197, 0.323)	-
Bleeding	1.220 (0.682, 2.183)	0.502
No Bleeding, REF	0.247 (0.188, 0.325)	-
Abrasion	1.905 (1.054, 3.443)	0.033*
No Abrasion, REF	0.228 (0.174, 0.300)	-
Dislocation	1.455 (0.623, 3.396)	0.386
No Dislocation, REF	0.250 (0.194, 0.322)	-
Contusion	0.598 (0.173, 2.071)	0.417
No Contusion, REF	0.264 (0.206, 0.338)	-
Other	1.714 (0.401, 7.330)	0.467
No Other, REF	0.167 (0.049, 0.566)	-
Body Part Injured		
Head/Face	1.322 (0.793, 2.206)	0.284
No Head/Face Injury, REF	0.236 (0.175, 0.317)	-
Neck	1.472 (0.382, 5.674)	0.575
No Neck Injury, REF	0.255 (0.199, 0.326)	-
Upper Limb	1.025 (0.627, 1.674)	0.922
No Up. Limb Injury, REF	0.255 (0.186, 0.349)	-
Chest/Abdomen	2.114 (1.034, 4.322)	0.040*
No Chest/Ab Inj., REF	0.236 (0.182, 0.307)	-
Spine	0.765 (0.254, 2.301)	0.633
No Spine Injury, REF	0.262 (0.204, 0.335)	-
Lower Limb	1.462 (0.900, 2.374)	0.125
No Low. Limb Injury, REF	0.213 (0.149, 0.303)	-

3.3.1.2 Multivariable Logistic Models with Outcome of Stage 1 Ambulance

Two multivariable models were created to assess predictors of people using an ambulance to get to the first health facility and the results are reported in Table 14. The first model included injury mechanism, alcohol, location type, injury type and body part injured as predictors, and the second model included age and gender in addition to all of the variables in the first model. In the first model, odds of using an ambulance to get to the first health facility were 94% higher in the group that reported alcohol use within six hours of the injury event than those who did not report alcohol use ($p<0.05$). Alcohol use did not significantly predict use of an ambulance in the fully specified model (Table 14). Compared to injuries that occurred in the street, injuries that occurred at home had significantly lower odds of using an ambulance in both models.

Table 14: Predictors of Ambulance Transport to First Health Facility using Multivariable Logistic Regression

	Stage 1 Ambulance			
	Odds Ratio (95% CI), P-Value			
Model Intercept	0.301 (0.187, 0.483)		0.415 (0.234, 0.738)	
Injury Mechanism				
Fall	1.490 (0.421, 5.281)	0.537	1.692 (0.470, 6.090)	0.421
Stab/Cut	0.698 (0.197, 2.469)	0.577	0.616 (0.173, 2.190)	0.454
Other Blunt	0.935 (0.259, 3.374)	0.918	0.872 (0.242, 3.147)	0.834
Force Other	1.117 (0.220, 5.683)	0.894	1.153 (0.222, 5.991)	0.865
Alcohol				
Yes	1.943 (1.043, 3.617)	0.036*	1.692 (0.867, 3.305)	0.123
Location Type				
Home	0.255 (0.076, 0.855)	0.027*	0.276 (0.082, 0.935)	0.039*
Work	0.445 (0.125, 1.578)	0.21	0.417 (0.116, 1.493)	0.179
Market	-	-	-	-
Other	0.297 (0.067, 1.319)	0.111	0.278 (0.063, 1.230)	0.092

Injury Type				
Open Wound	1.991 (0.980, 4.043)	0.057	2.035 (0.990, 4.185)	0.053
Abrasion	1.190 (0.597, 2.373)	0.621	1.066 (0.528, 2.151)	0.858
Body Part Injured				
Chest/Abdomen	2.159 (0.949, 4.910)	0.066	2.265 (0.973, 5.275)	0.058
Age				
40 to 55			0.707 (0.374, 1.336)	0.285
56 to 95			0.573 (0.268, 1.222)	0.149
Gender				
Female			0.780 (0.422, 1.441)	0.428

3.4 GIS Spatial Analysis Results

Longitude and latitude coordinates were obtained from the description of the injury event locations for 400 participants in this study. The coordinates of five injury locations could not be obtained from the description provided by the participants.

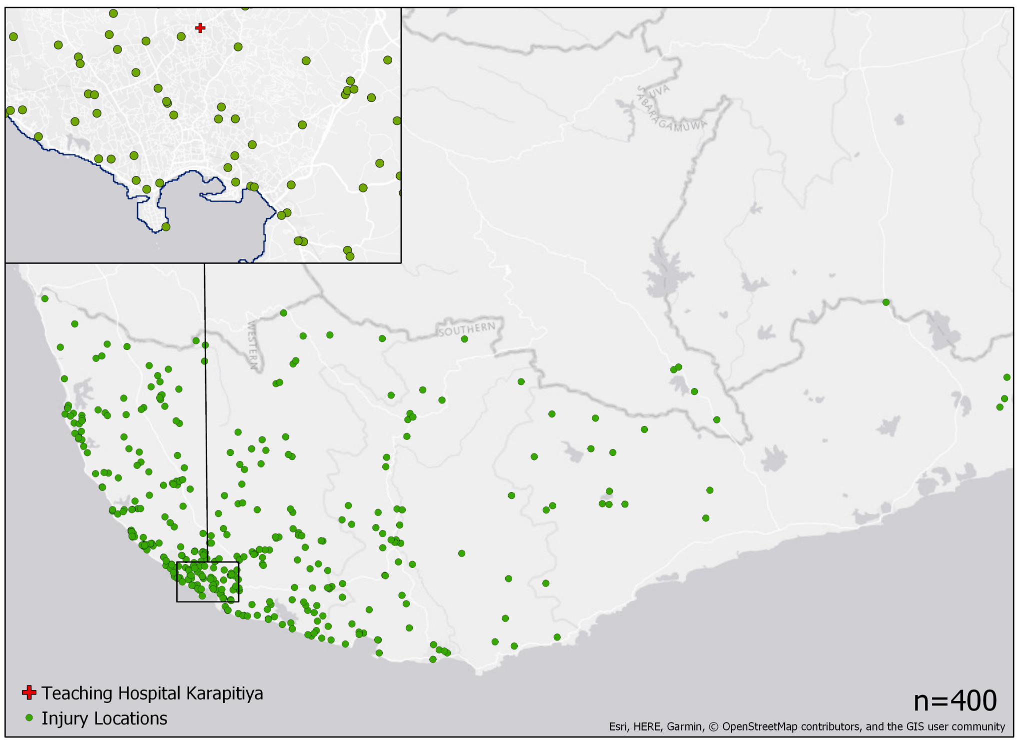

Figure 4: Coordinates of injury locations for the study sample. Each green dot represents one injury in the study (n=400)

Injury locations were also displayed by mode of transport used to get to first health facility to determine if there were any spatial patterns present.

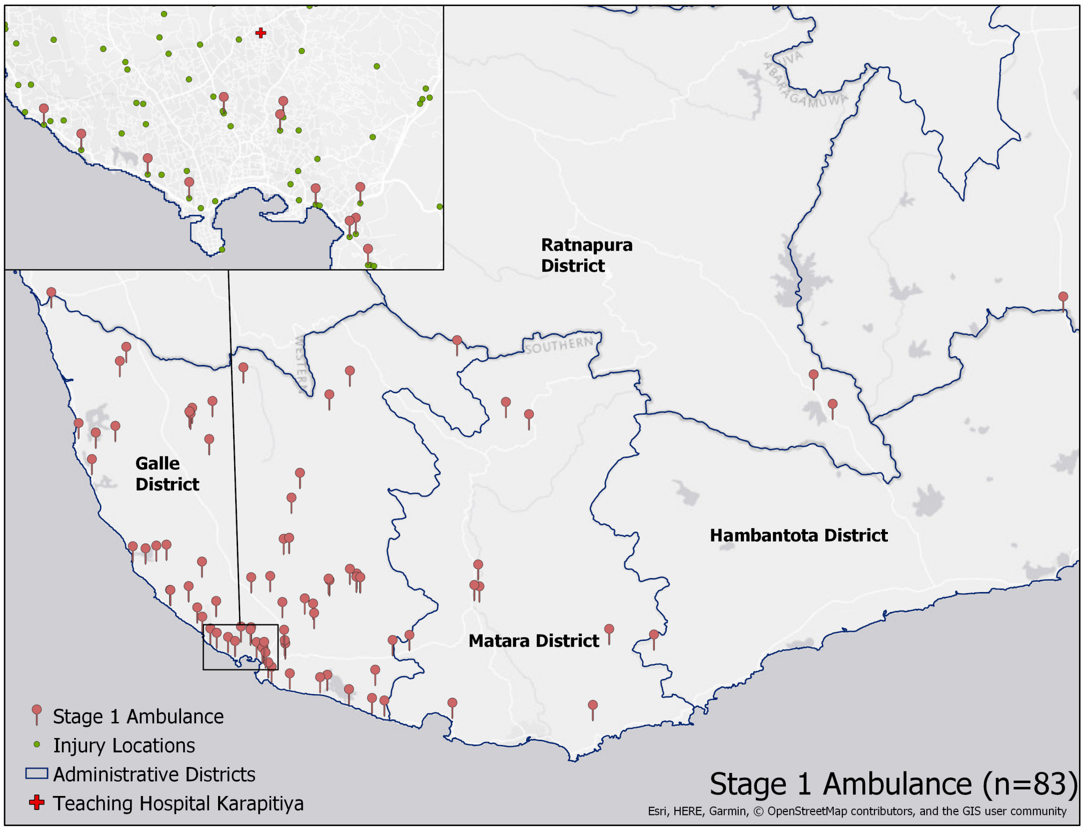

Figure 5: Coordinate of injury locations where ambulance was used to get to first health facility

4. Discussion

This study examined characteristics of the prehospital transportation and care of 405 patients with externally-caused injuries that were admitted to the emergency trauma center at THK. Patient demographics and injury event were assessed as predictors of prehospital transportation and care, and prehospital transportation and care variables were examined as effect modifiers of the relationship between injury event and length of hospital stay.

The results of our study indicate that 20.5% of people used an ambulance to get to the first health facility, while over half of the people in our study used a tuk-tuk, more than half received medical care before arriving at THK, and transport time to first health facility was less than 20 minutes for 54.1% of participants. Age, injury mechanism, alcohol use within 6 hours of injury, location type where injury occurred, open wound, abrasion, and chest/abdomen injury were all significantly associated with ambulance transport to the first health facility. In the fully specified multivariable model, only location type where injury occurred remained significantly associated with ambulance transport to the first health facility. Furthermore, our results suggest that effect of medical care before arrival at THK as well as the effect of mode of transportation used to get to first health facility on length of hospital stay varies depending on injury type.

4.1 Aim 1: Injury Event and Prehospital Transportation & Care Characteristics

As with many other injury studies, our study sample consisted of more men than women [25, 27, 29, 33, 55, 56]. The age distribution of our study population is similar to other studies, with more injuries occurring among participants in the 18 to 39 age group than any other group [14, 15, 57]. However, the average age in this study was 44 years old which is older than some other injury studies[14, 58]. This discrepancy is likely attributable to the current study excluding anyone younger than 18 years old which increased the average age of participants in our study sample. In addition to patient characteristics, the three most common mechanisms of injury (RTI, falls, other blunt/mechanical forces) reported in this study aligned with those of a previous study conducted in the Galle district[14] as well as other injury studies conducted in resource-limited settings[55, 57]. The previous study was a population-based, cross-sectional survey used to gather data from 2000 households to determine the incidence of nonfatal injuries, fatal injuries, and injuries that resulted in disability within the past 30 days. In another community based survey from two rural villages in the Kandy district, the most common mechanisms of injury reported were animal bites, followed by falls, and objects fallen on victim [15]. Given that the most common injuries were RTI and falls, it is not surprising that most injuries in the current study, as well in other studies occurred in the street or at home. Fractures and lacerations were the most common injury types present in our study sample and extremities were the most frequent body part injured. This is in accordance with a similar-designed study conducted in Haiti[27]. In terms of injury event characteristics and patient demographics, this studies reflects that of other injury studies in resource-limited settings, and any differences in the findings can likely be linked to the differences in the data collection process. Data collection for our study was based out of a tertiary-care hospital, whereas the other studies were population based, community surveys[14, 15].

While patient characteristics and injury event characteristics found in this study sample align with previous studies, characteristics of prehospital transportation and care were different which could be attributed to the health care delivery infrastructure as well as the more developed EMS system. In 2016, after a grant from the Indian government, Sri Lanka launched an ambulance service that is free of charge and began operation in the Southern province before expanding to the Western province[39]. If present, ambulance fleets are typically concentrated in bigger cities at major hospitals rather than lower level, more rural hospitals. Ambulance transport to first health facility was markedly higher in this study (20.5%) than similar studies conducted in different resource-limited settings[24, 33, 59]. It is possible that this is due to data collection settings as well as the more developed EMS system in the region. Because data collection was based in a large, tertiary teaching hospital, the number found in our study could be higher than what would be observed in a lower level hospital. Free ambulance transport could have also contributed to the higher proportion of ambulance utilization observed in our study, as cost of ambulance transport has been cited as a barrier to usage in other resource-limited settings[24, 25, 53].

Transport times to the first health facility were shorter than what has been reported in similar studies[26, 27]. Over half of the participants in this study reported transport times that were 20 minutes or less to the first health facility with average transport times for stages 1,2, and 3 being 27, 55, and 72 minutes respectively. Other studies have reported transport times more than twice as long as times reported in this study[26, 27, 29, 59]. One potential explanation for the shorter transport time in our study is most Sri Lankans live within 3 kilometers of a health facility[60]. Longer transport times observed in stages 2 and 3 are due to the referrals from lower level facilities located farther away than those people who came directly to THK following their injury.

57.8% of people in this study received medical care before arriving at THK. Care ranged from a family member cleaning and dressing a wound, to stabilization of a fracture at a base or district general hospital. Given the extensive, public hospital network in Sri Lanka, it is not surprising that more than half of the patients in our study had some type of care prior to arriving at THK[45, 60]. Furthermore, since data collection was based out of a tertiary care facility, a substantial portion of the participants were referred to THK for specialist care from other health facilities.

4.2 Aim 2: Predictors of ambulance transport to first health facility

Following bivariate analysis, factors that were significantly associated with ambulance transport to first health facility included age, injury mechanism, use of alcohol within six hours of injury event, location where injury occurred, as well as injury type. In the current study, people in the 56 to 95 age group had lower odds of using an ambulance when compared to the 18 to 39 age group. This results conflicts with previous studies in resource-limited settings[24, 25, 59]. Since the ambulance service is relatively new, there may be a lack of awareness among the older age group or a general lack of trust in the ambulance service[61]. Additionally, in our study, over half of the people in the oldest age group were injured at home and injured by a fall. Both being injured at home and a fall were associated with lower odds of using an ambulance to travel to first health facility. If a patient was injured at home, they were more likely to travel to a health facility via a privately-owned vehicle than ambulance which could explain the discrepancy between this study and previous studies in resource-limited settings.

4.3 Aim 3: Stage 1 Mode, Transport Time, and Prior Medical Care as Effect Modifiers

In order to delineate how mode of transport and time of transport to first health facility, as well as medical care prior to arriving at THK affect the relationship between injury event and length of hospital stay a multivariable model with interaction terms was created. Three exposures that were included in this model were fracture, open wound, and spine injury. These were chosen due to their strong association with our outcome variable length of stay, following a backwards elimination strategy from the full multivariable model. The effect of stage 1 mode, transport time, and prior medical treatment varied depending on the exposure. For spinal injuries, none of the hypothesized effect modifiers were significant. One potential explanation is that availability of orthopedic or neurosurgeons is low relative to the demand, and thus all people with spinal injuries remain in the hospital until they can be seen by a specialist. Length of hospital stay for people with spinal injuries may be more strongly related to the availability of the appropriate specialist than any of our hypothesized effect modifiers (transport time, mode of transport, prior medical care). This result could change if a different outcome were to be measured in future studies.

For people with open wounds, transport time and ambulance transport were significant effect modifiers of the relationship between injury type and length of hospital stay. Surprisingly, people with open wounds who took longer than twenty minutes to get to the first health facility had hospital stays that were about 47% shorter compared to those with open wounds who took less than twenty minutes to get to the first health facility. One potential explanation for this finding is that those who were traveling from further away had less severe injuries than those that were injured closer to a health facility. Those with more severe injuries are more likely to have a longer hospital stay, and these people could have had longer transport times which could cause the interaction between open wound and transport time to first health facility to be significant. In addition to transport time, ambulance transport to first health facility for people with open wounds resulted in hospital stays that were approximately 42% shorter compared to those with open wounds who used a tuk-tuk to get to the first health facility. This result suggests that ambulance transport to first health facility is significantly associated with length of hospital stay, and open wounds can be managed out of the hospital which may help alleviate the demands on hospital resources in a resource-constrained setting.

The only significant effect modifier for people with fractures was medical treatment prior to arriving at THK. People with fractures who received care prior to arrival at THK had 42% shorter hospital stays compared to those with fractures who did not receive treatment prior to arriving at THK. Most of this treatment involved stabilizing or splinting the fracture, with some wound cleaning and dressing. The mechanical environment of bone fractures has been shown to have an effect on the time of bone healing[62]. Earlier stabilization of fracture in a lower level hospital could promote shorter healing times or reduced chances of infection or other complications that would increase the length of stay at the tertiary care facility. Longer length of stay at THK would increase the demand on already limited orthopedic specialists. These results suggest that managing fractures at lower level facilities could be an effective means to reduce the demand on resources at higher level health care facilities[45].

4.4 Study Strengths and Limitations

Sri Lanka is currently in the process of developing an EMS system, but data on prehospital transportation and care is not collected when a patient arrives at the hospital. Our study adds valuable information that could help inform next steps in the development of EMS in Sri Lanka. The sample size in our study allowed us to construct models that examined the effects of prehospital transportation and care on injury event and length of stay relationship. This could prove useful in guiding decisions or developing guidelines about the appropriate level health facility to take patients to, given their injuries.

There are several limitations of this study that should be noted. Data collection was based out of a tertiary care hospital, thus introducing selection or sampling bias. People who had more severe injuries and died before reaching the hospital were not included in the study sample, as well as those people whose injuries were treated at other health facilities and did not require referral to THK for specialist care. However, because THK is the largest tertiary care facility in the Southern province, it provided the most representative sample of prehospital transportation and care trends compared to if data collection was based out of a lower level health facility. An additional limitation of the current study is that no injury severity score was reported for patients. This could bias estimates derived from models that include injury event characteristics and prehospital transportation and care as predictor variables on length of hospital stay. Indirect indicators of injury severity were measured and adjusted for in the multivariable models which reduces the effect this suspected confounder has on our outcome of interest, length of hospital stay. The final limitation of this study is the limited generalizability of the results. We could not collect data from the proxies of patients receiving care in the ICU which resulted in more severe injuries being excluded from the study sample. As such, our results do not generalize to those with more severe injuries but they do provide an indication of the effect of prehospital care on the relationship between injury event and length of hospital stay and a baseline description of prehospital transportation and care trends in areas where there is a tertiary care facility. The results of this study generalize to other regions where there is a tertiary care facility or teaching hospital, but they do not generalize to more rural regions in Sri Lanka as ambulance use to first health facility is likely lower in more rural areas.

4.5 Implications for Policy and Practice

The Ministry of Health in Sri Lanka operates an extensive network of hospitals that provide health care to the people of Sri Lanka free of charge but there is popular notion that the quality of care received at primary and secondary facilities is poor so people tend to bypass these facilities and go directly to a tertiary care facility [45, 60]. This has resulted in overutilization of tertiary care facilities leading to longer wait times and overcrowding of tertiary institutions[45]. Additionally, it was not until the tsunami in 2004, that health officials and the people of Sri Lanka realized the need for emergency medical services, and began developing a prehospital care system[30, 63, 64]. The results of this study suggest that ambulance transport to the first health facility and treatment at primary and secondary health facilities reduces the length of stay at a tertiary hospital for some types of injuries.

This study demonstrates the need to ensure that secondary health facilities as well as ambulances are properly equipped to treat fractures and open wounds. In addition to equipment, it is important to improve communication between ambulances and hospitals so that patients are transferred to the appropriate level facility given their injuries. Furthermore, a public education campaign that aims to increase awareness of secondary health facilities' ability to treat certain types of injuries, as well as what actions a person should take when injured, could prove useful in reducing the burden on overcrowded tertiary facilities. This public education campaign could be one of many steps taken to begin changing the public's perception of primary and secondary care facilities. It is critical that this education campaign also reaches tuk-tuk drivers, as the results of this study show that over 50% of people still use tuk-tuks to travel to the hospital. In addition to this more general education campaign, there should be a more involved training for tuk-tuk drivers that covers first aid and what types of injuries each level hospital has the capacity to treat. This could be incorporated into the licensing process as one day of training as has been done in a previous study that administered basic first aid training to taxi drivers in Madagascar[36]. If people using tuk-tuks were transferred to the appropriate level health facility given their injuries, the effects of this could be immediately realized with decreased wait times and overcrowding at tertiary institutions.

4.6 Implications for Future Research

A free ambulance service was launched in 2016 and the current study revealed that 20.5% of people used an ambulance to travel to the first health facility. Future research on the prehospital transportation and care of those with externally-caused, acute injuries should include those with more severe injuries in order to increase the generalizability of the results. Additionally, future studies should examine in more detail the characteristics of those who use an ambulance, the type of injuries that affect people who use an ambulance, as well as the type of care provided by emergency personnel and whether that care is effective in improving patient outcomes. Other comparisons of interest would be total prehospital time between those who use an ambulance and those who do not. For those that use an ambulance, the effect of different prehospital time intervals (response, on-scene, transport) on patient outcomes should be explored. Understanding the characteristics of those who use an ambulance as well as the relationship between ambulance use and patient outcomes would aid in identifying strengths in the current EMS system as well as areas for improvement. The goal of this line of research is to improve access to effective and timely EMS services for the people of Sri Lanka so that the burden of traumatic injuries may be reduced.

5. Conclusions

Most people in this study used a tuk-tuk to get to the first health facility, followed by car or van (21.5%), ambulance (20.5%), and other (5.2%). Over half of the study sample received some type of medical care before arriving at THK, and half took twenty minutes or less to get to the first health facility. Age, injury mechanism, alcohol use, location type, open wound, abrasion, and chest/abdomen injury were associated with ambulance transport to the first health facility. Ambulance transport and medical treatment prior to arrival at THK were found to be associated with a decreased length of hospital stay for some types of injuries. The most important findings from this study are the factors associated with ambulance use to the first health facility as well as how prior medical treatment and ambulance transport affect the relationship between injury event and length of stay. The results of this study demonstrate the importance of ensuring that secondary care facilities and ambulance are properly equipped to treat open wounds so that length of stays at overcrowded, resource-constrained tertiary facilities are reduced. It is also important to understand the factors associated with ambulance transport to the first health facility so that this data could be used to develop strategies to reach those populations who are not using ambulances. The overarching goal of this is to improve access to effective and timely EMS services for people with traumatic injuries which would result in improved patient outcomes and a reduced burden of injury in Sri Lanka.

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