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Effect of weather and time on trauma events determined using emergency medical service registry data

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ABSTRACT

Introduction: Trauma admissions are associated with weather and temporal factors; however, previous study results regarding these factors are contradictory. We hypothesised that weather and temporal factors have different effects on specific trauma events in an emergency medical service (EMS) system.
Methods: EMS data from January 1, 2009, to December 31, 2010, were obtained from the fire department of Taipei City and associated with the local weather data. EMS trauma events were categorised into total trauma, traffic accidents (TAs), motorbike accidents (MBAs), and falls. Hourly data on trauma patients were analysed using the zero-inflated Poisson model.
Results: The hourly incidence of total trauma increased with the magnitude of precipitation (incidence rate ratio [IRR] = 1.06, 1.09, and 1.11 in light, moderate, and heavy rain, respectively), and this effect was more prominent in fall patients than in patients with other injuries (IRR = 1.07, 1.21, and 1.32). However, the hourly incidence of TAs and MBAs was associated only with light rain (IRR = 1.11 and 1.06, respectively). An hour of sunshine exposure was associated with an increase in the hourly incidence of all groups, and higher temperatures were associated with an increased hourly incidence of total trauma, TAs, and MBAs, but not falls. The hourly incidence of falls increased only in late fall and winter.

Compared with the hourly incidence between 3 am and 7 am, the hourly incidence of all groups plateaued between 7 am and 11 pm and declined from 11 pm to 3 am. During the plateau period, 2 peaks in the incidence of TAs (IRR = 5.03 and 5.07, respectively) and MBAs (IRR = 5.81 and 5.51, respectively) were observed during 7–11 am and 3–7 pm. The hourly incidence of total trauma, TAs, and MBAs plateaued during workdays, peaked on Fridays, declined on Saturdays, and troughed on Sundays. The incidence of falls increased only on Mondays (IRR = 1.09).
Conclusions: Weather and temporal factors had different impacts on the incidence of traffic-related accidents and falls. Therefore, EMS data may have implications in preventing injuries and planning resource use for prehospital trauma rescue.

Introduction

Trauma occurrence is commonly believed to be influenced by specific weather conditions and temporal factors. Numerous studies have reported that temperature is positively associated with trauma admissions [1–3] but one study reported that no weather factor affected adult trauma and hip fracture admissions [4]. In addition, high temperature increased emergency department (ED) visits and admissions for paediatric trauma [3–5]. Previous studies have reported equivocal findings regarding the effect of rain on trauma admissions. In one study in the United States, rain was associated with a decrease in trauma admissions and had no effect on admissions related to motor vehicle crashes [1]. However, another study in the United States reported a 60–78%

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increase in trauma admissions for each inch of precipitation in a 3-h period [2]. Two studies in the United Kingdom reported no association between rain and adult and pediatric trauma admissions [3,4]. However, these two studies suggested that sunshine and temperature are positively correlated with trauma admissions.

In a study in Israel, the number of ED visits was higher on weekdays and declined toward the weekends [6]. However, the incidence of trauma visits was not significantly high on weekends or during holidays in a pediatric ED study [5]. A study in the United Kingdom reported an increase in admissions for adult trauma and hip fractures on weekdays [4], but several studies have reported more trauma admissions on weekends [1–3].

Previous studies have focused on the effect of weather and time on daily trauma admissions. However, the effect of weather and time on the hourly incidence of trauma recorded by an emergency medical service (EMS) system and subsequent impacts on EDs have not been investigated in these studies. People in Taiwan use motorbikes as the most common means of transport; therefore, injuries resulting from traffic accidents (TAs) differ from those occurring in Western countries [7]. In this study, we evaluated the influence of weather and temporal factors on the incidence of trauma events in Taipei City, Taiwan, recorded by an EMS system.

Methods

We conducted a secondary data analysis to evaluate the effect of weather and time on trauma events by using an EMS database. The joint institutional review board of Taipei Medical University approved this study (Approval No: 201210034).

EMS registry database

Data on patients who requested EMS from January 1, 2009, to December 31, 2010, were obtained from the fire department of Taipei City. Forty-five primary EMS agencies are distributed among four districts of the fire department. The data available for each patient in the EMS registry database included sex, age, time of event, location of event, mechanism of event, vital signs, emergency procedures received, EMS agency activated, and the receiving hospital. Injury was defined as any blunt-, penetrating-, burn-, or drowning-related harm for which the EMS provider determined trauma to be the primary clinical insult. Patients with injury-related insult who (1) died on the scene without transfer or (2) received EMS transfer were enrolled in the study. A database containing EMS responses to trauma events for every hour was constructed. The following four types of hourly trauma event were analysed:

1. Total trauma events;
2. Traffic accidents (TAs): Injury sustained through any type of traffic-related accident;
3. Motorbike accidents (MBAs): Experience of any type of motorbike-related injury;
4. Falls: Any injury resulting from a person coming to rest inadvertently on the ground or floor.

Weather data

Weather data were obtained from the Taiwan Central Weather Bureau. The data consisted of hourly measurements of temperature (°C), precipitation (mm), sunshine (h), humidity (%), and mean wind speed (m/s). Rain was categorised as light (precipitation at a rate lower than 2.5 mm/h), moderate (precipitation at a rate between 2.5 and 7.6 mm/h), or heavy (precipitation at a rate higher than 7.6 mm/h) [8].

Statistical analysis

We used the zero-inflated Poisson (ZIP) model to analyse the relationship between the hourly incidence of trauma according to EMS records and weather–temporal factors. The default distribution for the data on the trauma count was the Poisson distribution. However, trauma counts can be overdispersed because zero or multiple people can be involved in a single event. Thus, the assumption that the mean equals the variance is violated [2–4]. Because our data contained many zero values, the ZIP model was considered the most appropriate model for the data.

The hourly incidence of trauma was calculated for each fire district. Taipei City has 15 weather stations. We obtained corresponding hourly weather data from weather stations located near the center of each of the four fire districts. Hourly trauma events recorded in the EMS data for each fire district were linked with the local weather data. Weather factors, temporal variables, and the fire districts were used as independent variables in the multiple ZIP regression model for analyzing the relationships between the hourly trauma incidence and these variables.

Statistical Analysis Software Version 9.3 (SAS Institute Cary, NC, USA) was employed for all statistical analyses.

Results

In this study, we included 68 927 injured patients (Table 1). Male patients were predominant (55.5%). Most injured patients were in the adult group (age: 18−64 years) (74.2%) followed by the elderly group (age: ≥65 years) (20.9%). The most frequent cause of

Table 1
Distribution of demographic characteristics and injury mechanisms.

Variables	Total *N* = 68927	
	N	%
Sex		
Male	38232	55.47
Female	30597	44.39
Undocumented	98	0.14
Age (y)		
<18	3221	4.67
18–64	51150	74.21
≥65	14405	20.90
Undocumented	151	0.22
Injury mechanism		
Traffic	**40919**	**59.37**
MVA[a]	1240	1.8
MBA[b]	33121	48.05
Bike	2551	3.70
Pedestrian	3932	5.71
Unspecified	75	0.11
Fall	**17684**	**25.66**
Other	**10324**	**14.97**
OHCA[c]	300	0.44
Knife, penetration	174	0.25
Gun, penetration	13	0.02
Unspecified, penetration	129	0.19
High fall	671	0.97
Cut	1850	2.68
Crush	614	0.89
Contusion	262	0.38
Sprain	81	0.12
Burn	290	0.42
Bite	212	0.31
Drowning	32	0.05
Electrocution	20	0.03
Unspecified	5676	8.23

[a] MVA: motor vehicle accident.
[b] MBA: motor bike accident.
[c] OHCA: out-hospital cardiac death.