THE ANNALS OF THORACIC SURGERY

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Ann Thorac Surg 2009;88:1124-1130
DOI: 10.1016/j.athoracsur.2009.06.002

Print ISSN: 0003-4975; eISSN: 1552-6259.

Risk Factors for 24-Hour Mortality After Traumatic Rib Fractures Owing to Motor Vehicle Accidents: A Nationwide Population-Based Study

Yung-Chang Lien, MD, Chao-Hung Chen, MD, MPH, and Herng-Ching Lin, PhD

Division of Thoracic Surgery, Department of Surgery, Taipei Medical University and Hospital, Department of Thoracic Surgery, Mackay Memorial Hospital, Mackay Medicine, Nursing, and Management College, and School of Health Care Administration, Taipei Medical University, Taipei, Taiwan

Background. **Accurate identification of patients at high risk of death as a result of major chest trauma is essential within a trauma system. We used 3-year population-based data in Taiwan to evaluate risk factors associated with 24-hour mortality among adults with obvious rib fractures and needing hospitalization after traffic accidents.**

Methods. **Pooled data from Taiwan's National Health Insurance Research Database for the years 2002 through 2004 were used. A total of 18,856 patients hospitalized with rib fractures after traffic accidents were included. Multivariate logistic regression using generalized estimating equations was performed to explore the relationship between 24-hour mortality and patients' age, sex, and comorbid conditions, as well as hospital characteristics, adjusting for social factors and any clustering of the sampled patients by hospital.**

Results. **Of patients in the sample, 459 (2.4%) died within 24 hours of admission. Patients who had six or more rib fractures were three times more likely to die within 24 hours of admission compared with patients with only one rib fracture (odds ratio [OR], 3.16; $p < 0.001$). The adjusted odds of death within 24 hours were higher for patients who had hemopneumothorax (OR, 3.15; $p < 0.001$), extremity fractures (OR, 1.74; $p < 0.001$), pelvic fractures (OR, 2.92; $p < 0.001$), head injuries (OR, 4.29; $p < 0.001$), spleen injury (OR, 1.83; $p < 0.05$), hepatic injury (OR, 4.39; $p < 0.001$), heart injury (OR, 4.48; $p < 0.001$), and diaphragm injury (OR, 3.16; $p < 0.05$) compared with patients who had none of these injuries.**

Conclusions. **We concluded that more than six ribs fractured, heart injuries, hepatic injuries, head injuries, and advanced age are the most important determinants of 24-hour mortality after thoracic trauma from traffic accidents.**

(Ann Thorac Surg 2009;88:1124–30)

Trauma is the leading cause of death in the first four decades of life [1]. Thoracic traumas constitute 10% to 15% of all traumas and are the cause of death in 25% of all fatalities attributable to trauma [2]. Blunt chest injuries particularly attract attention because of the increasing incidence of traffic accidents. Although most chest wall injuries are benign and can be followed up without hospitalization, trauma associated with the thoracic cage may cause profound, sometimes fatal pathophysiologic changes [3].

Blunt trauma from motor vehicle crashes accounts for 70% to 80% of thoracic injuries [4]. Thoracic trauma may include injury to the chest wall, pleura, tracheobronchial tree, lungs, diaphragm, esophagus, heart, and major blood vessels, and may be associated with other major organ injuries. Initially these patients are usually transported from the accident site to the nearest available hospital. According to a study by Acosta and colleagues [5], 70% of trauma victims die within the first 24 hours of admission. It is essential for any trauma system to accurately identify patients at highest risk of mortality as a result of major chest trauma.

We therefore used 3-year population-based data in Taiwan to evaluate the possible risk factors for 24-hour mortality in adults who had experienced traffic accidents and had obvious rib fractures and needed hospitalization. In addition to thoracic trauma and associated injuries, our study examined the association between hospital characteristics and 24-hour mortality for adults with blunt chest injuries attributable to traffic accidents.

Material and Methods

Database

This study uses pooled data for the years 2002, 2003, and 2004 obtained from the National Health Insurance Research Database published by Taiwan's National Health Research Institute. The National Health Insurance Research Database covers all medical benefit claims for approximately 98% of the entire Taiwan population. The National Health Insurance Research Database also includes a registry of contracted medical facilities, a registry of board-certified surgeons, and details of orders and

Accepted for publication June 1, 2009.

Address correspondence to Dr Lin, School of Health Care Administration, Taipei Medical University, 250 Wu-Hsing St, Taipei, 110, Taiwan; e-mail: henry11111@tmu.edu.tw.

Published by Elsevier Inc

0003-4975/09/$36.00
doi:10.1016/j.athoracsur.2009.06.002

expenditures on prescriptions dispensed at contracted pharmacies. It also provides principal procedure codes along with one principal diagnosis code, and up to four secondary diagnosis codes for each patient, using the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM). The validity of diagnoses is usually a concern with claims data sets. Thus, the Bureau of National Health Insurance carries out routine sampling of patient charts to crosscheck with each hospital's claims, followed by punitive measures for fraudulent coding. This deterrent is further boosted by the National Health Insurance's reimbursement system, which ties a hospital's reimbursement rate to its patient severity profile. It is generally believed that the National Health Insurance's checks and balances promote accurate coding.

In our data set, all personal identifiers were encrypted before release for public access for research purposes by the Bureau of National Health Insurance. After consulting the institutional review board director of our university, the study was exempt from full review by the institutional review board board, as only unidentified secondary data were used.

Study Sample

The study sample was identified by a diagnosis of rib fracture (ICD-9-CM code 807, 807.0, or 807.1). Of more than eight million inpatient records within the data set covering the period of this study, 34,081 were admitted because of rib fractures. We then excluded sampled patients whose rib fractures were not caused by traffic accidents (n = 15,093). We also excluded all 30-day readmissions for the treatment of rib fractures, regarding these as the same episode as the first-time admission (n = 4). In addition, children's ribs are more flexible in nature compared with those of adults, which may lead to different consequences after thoracic trauma. For example, children experiencing simple trauma may have injuries to the intrathoracic viscera rather than rib fractures [6]. Therefore, all patients younger than 18 years of age (n = 122) were excluded from the data set. Ultimately, our study sample consisted of 18,856 patients.

Key Variables of Interest

The primary study outcome was dichotomous: whether or not a patient was dead within 24 hours after admission. For this study, the National Health Insurance Research Database was linked to the "cause of death" data file by the patient's national identification number with the assistance of the Department of Health in Taiwan. Because the registration of all deaths is mandatory, the data are considered to be very accurate and comprehensive. This linkage allowed us to identify all deaths occurring within 24 hours of hospitalization. The independent

Table 1. Distribution of Patient and Hospital Characteristics for Cases With Traumatic Rib Fractures After Traffic Accidents in Taiwan, 2002–2004 (n = 18,856)

			Deceased Within 24 Hours				
	Totals		Yes		No		
Variables	No.	Column %	No.	Row %	No.	Row %	*p* Value
Patient characteristics							
Patient sex							0.923
Male	13,217	70.1	311	2.4	12,906	97.6	
Female	5,639	29.9	134	2.4	5,505	97.6	
Patient age (y)							$<$0.001
18–44	5,307	28.1	90	1.7	5,217	98.3	
45–64	8,470	44.9	161	1.9	8,309	98.1	
65–74	3,235	17.2	95	2.9	3,140	97.1	
$>$74	1,844	9.8	99	5.4	1,745	94.6	
Hospital characteristics							
Hospital level							$<$0.001
Medical center	3,938	20.9	99	2.5	3,839	97.5	
Regional hospital	6,883	47.1	249	2.8	8,634	97.2	
District hospital	6,035	32.0	97	1.6	5,938	98.4	
Hospital ownership							0.588
Public	4,005	21.2	94	2.4	3,911	97.6	
Private not-for-profit	7,340	38.9	183	2.5	7,157	97.5	
Private for-profit	7,511	39.8	168	2.2	7,343	97.8	0.207
Hospital location							
Northern	5,579	29.6	120	2.2	5,459	97.9	
Central	6,045	32.1	163	2.7	5,882	97.3	
Southern	6,739	35.7	150	2.2	6,589	97.8	
Eastern	493	2.6	12	2.4	481	97.6	

Table 2. Distribution of Comorbidities Among Patients With Traumatic Rib Fractures After Traffic Accidents in Taiwan, 2002–2004 (n = 18,856)

			Deceased Within 24 Hours				
	Totals		Yes		No		
Variables	No.	Column %	No.	Row %	No.	Row %	*p* Value
Number of ribs fractured							<0.001
1	1,390	7.4	6	0.4	1,384	99.6	
2	1,301	6.9	9	0.7	1,292	99.3	
3	1,143	6.1	14	1.2	1,129	98.8	
4	803	4.3	10	1.3	793	98.8	
5	534	2.8	6	1.1	528	98.9	
6 or more	538	2.6	13	2.4	525	97.6	
Unspecified	13,147	29.7	387	2.9	12,760	97.1	
Pulmonary complications							<0.001
Pneumothorax	660	3.5	19	2.9	641	97.1	
Hemothorax	2,858	15.2	109	3.8	2,749	96.2	
Hemopneumothorax	1,120	5.9	62	5.5	1,058	94.5	
None	14,218	75.4	255	1.8	13,963	98.2	
Flail chest							0.719
Yes	66	0.4	2	3.0	64	97.0	
No	18,790	99.3	443	2.4	18,347	97.6	
Fracture of extremities							<0.001
Yes	2,760	14.6	105	3.8	2,655	96.2	
No	16,096	85.4	340	2.1	15,756	97.9	
Fracture of vertebral column							0.420
Yes	481	2.6	14	2.9	467	97.1	
No	18,375	97.4	431	2.4	17,944	97.7	
Fracture of pelvis							<0.001
Yes	660	3.5	41	6.2	619	93.8	
No	18,196	96.5	404	2.2	17,792	97.8	
Head injury							<0.001
Yes	4,797	25.4	260	5.4	4,537	94.6	
No	14,059	74.6	185	1.3	13,874	98.7	
Spleen injury							0.003
Yes	452	2.4	20	4.4	432	95.6	
No	18,404	97.6	425	2.3	17,979	97.7	
Hepatic injury							<0.001
Yes	554	2.9	45	8.1	509	91.9	
No	18,302	97.1	400	2.2	17,902	97.8	
Fracture of sternum							0.846
Yes	35	0.2	1	2.9	34	97.1	
No	18,821	99.8	444	2.4	18,377	97.6	
Fracture of scapula							0.007
Yes	1,062	5.6	12	1.1	1,050	98.9	
No	17,794	94.4	433	2.4	17,361	97.6	
Heart injury							<0.001
Yes	73	0.4	8	11.0	65	89.0	
No	18,783	99.6	437	2.3	18,346	97.7	
Diaphragmatic injury							
Yes	44	0.2	5	11.4	39	88.6	<0.001
No	18,812	99.8	440	2.3	18,372	97.7	
Aortic rupture							<0.001
Yes	50	0.3	4	8.0	46	92.0	
No	18,806	99.7	441	2.3	18,365	97.7	

variables of interest were patient's age (18 to 44, 45 to 64, 65 to 74, and >74 years), sex, and comorbidities, and hospital characteristics. Comorbidities included pulmonary complications (pneumothorax [ICD-9-CM code 860.0 or 860.1], hemothorax [ICD-9-CM code 860.2 or 860.3], pneumohemothorax [ICD-9-CM code 860.4 or 960.5]), flail chest (ICD-9-CM code 807.4), extremity fracture (ICD-9-CM codes 812 through 828), vertebral column fracture (ICD-9-CM codes 805 through 806), pelvis fracture (ICD-9-CM code 808), sternum fracture (ICD-9-CM codes 807.2 through 807.3), scapula fracture (ICD-9-CM code 811), head injury (ICD-9-CM codes 800 through 804 or 851 through 854), spleen injury (ICD-9-CM code 865), hepatic injury (ICD-9-CM code 864), heart injury (ICD-9-CM codes 861.0 through 861.1), and diaphragmatic injury (ICD-9-CM codes 862.0 through 862.1).

Hospital characteristics included hospital ownership, accreditation level, and geographic location, with the hospital ownership variable being recorded as one of three types: public, private not-for-profit, and private for-profit hospitals. Within the variable of hospital accreditation level, each hospital was classified as a medical center (with a minimum of 500 beds), a regional hospital (minimum 250 beds), or a district hospital (minimum 20 beds); hospital level can therefore be used as a proxy for both hospital size and clinical service capabilities. Hospital teaching status was not included in this study as all medical centers and regional hospitals in Taiwan are teaching hospitals.

Statistical Analysis

The SAS statistical package (SAS System for Windows, Version 8.2; SAS Institute Inc, Cary, NC) was used to perform analysis of the data. Descriptive analyses, including frequency, percentage, mean, and standard deviation, were performed on the identified variables. Global χ^2 analyses were conducted to examine the relationships between 24-hour death and independent variables of interest. Multivariate logistic regression using generalized estimating equations was also performed to explore the relationship between 24-hour death and patient's age, sex, and comorbidities, as well as hospital characteristics, after adjusting for other factors and any clustering of the sampled patients among particular hospitals. A two-sided probability value of less than or equal to 0.05 was considered statistically significant.

Results

Table 1 describes the distribution of the sampled patients by patient demographics and hospital characteristics. Of the total 18,856 patients hospitalized for rib fractures during the 3-year study period, 70.1% were male, and the mean age of the patients was 53.6 years (standard deviation, 15.6 years).

Among the study sample, 459 patients (2.4%) were dead within 24 hours after admission, contributing to 55% of all 30-day mortalities (n = 827). Table 1 also presents the bivariate analyses of patient and hospital

Table 3. Crude and Adjusted Odds Ratios for 24-Hour Death in Taiwan, by Patient and Hospital Characteristics, 2002–2004 (n = 18,856)

	Deceased Within 24 Hours			
Variable	Crude OR, 95% CI		Adjusted OR, 95% CI	
Patient characteristics				
Patient age (y)				
18–44 (reference group)	1.00		1.00	
45–64	1.12	0.87–1.46	1.42[a]	1.09–1.86
65–74	1.75[c]	1.31–2.35	2.21[c]	1.63–2.99
>74	3.29[c]	2.46–4.40	4.14[c]	3.05–5.63
Number of ribs fractured				
1 (reference group)	1.00		1.00	
2	1.61	0.57–4.52	1.35	0.47–3.85
3	2.86[a]	1.10–7.46	2.44	0.93–6.41
4	2.91[a]	1.05–8.03	2.33	0.84–6.48
5	2.62	0.84–8.16	1.67	0.53–5.29
6 or more	5.71[c]	2.16–15.09	3.16[a]	1.18–8.51
Unspecified	6.99[c]	3.12–15.68	3.10[b]	1.37–7.02
Pulmonary complications				
Pneumothorax	1.62[a]	1.01–2.60	1.63[a]	1.00–2.66
Hemothorax	2.17[c]	1.73–2.73	2.10[c]	1.58–2.56
Hemopneumothorax	3.21[c]	2.41–4.27	3.15[c]	2.33–4.27
None (reference group)	1.00		1.00	
Fracture of extremities				
Yes	1.83[c]	1.47–2.29	1.74[c]	1.38–2.20
No (reference group)	1.00		1.00	
Fracture of pelvis				
Yes	2.92[c]	2.10–4.06	2.92[c]	2.06–4.14
No (reference group)	1.00		1.00	
Head injury				
Yes	4.30[c]	3.55–5.21	4.29[c]	3.49–5.27
No (reference group)	1.00		1.00	
Spleen injury				
Yes	1.96[b]	1.24–3.10	1.83[a]	1.13–2.97
No (reference group)	1.00		1.00	
Hepatic injury				
Yes	3.96[c]	2.87–5.45	4.39[c]	3.09–6.24
No (reference group)	1.00		1.00	
Fracture of scapula				
Yes	0.46[b]	0.26–0.82	0.52[a]	0.29–0.94
No (reference group)	1.00		1.00	
Heart injury				
Yes	5.17[c]	2.47–10.84	4.48[c]	2.02–0.98
No (reference group)	1.00		1.00	
Diaphragm injury				
Yes	5.36[c]	2.10–13.65	3.16[a]	1.15–8.65
No (reference group)	1.00		1.00	
Hospital characteristics				
Hospital level				
Medical center	1.58[b]	1.19–2.10	0.98	0.73–1.32
Regional hospital	1.77[c]	1.39–2.24	1.30[a]	1.02–1.67
District hospital (reference group)	1.00		1.00	

[a] $p < 0.05$. [b] $p < 0.01$. [c] $p < 0.001$.

CI = confidence interval; OR = odds ratio.

characteristics in relation to 24-hour death, indicating significant relationships between 24-hour death and patient age ($p < 0.001$) and hospital accreditation level ($p < 0.001$).

Table 2 describes the distribution of the sampled patients by patient comorbidities. A total of 25.4%, 15.2%, 14.6%, and 5.6% had comorbidities of head injury, hemothorax, extremity fractures, and scapula fractures, respectively. Of 3,978 patients with hemothorax or hemopneumothorax, 26 patients (0.65%) had ruptured aorta. Twenty-four hour mortality was further associated with number of rib fractures ($p < 0.001$), pulmonary complications ($p < 0.001$), extremity fractures ($p < 0.001$), pelvis fractures ($p < 0.001$), head injury ($p < 0.001$), spleen injury ($p = 0.003$), hepatic injury ($p < 0.001$), scapula fractures ($p = 0.007$), heart injury ($p < 0.001$), diaphragmatic injury ($p < 0.001$), and aortic rupture ($p < 0.001$).

Table 3 provides the crude odds ratio (OR) estimates of the likelihood of 24-hour death, by patient and hospital characteristics. As expected, the odds of 24-hour death increased with patient age. Patients with pulmonary complications, extremity fractures, pelvis fractures, head injuries, spleen injury, hepatic injury, heart injury, and diaphragmatic injury had higher odds of 24-hour death than patients who did not.

Table 3 also shows adjusted OR of 24-hour death by patient and hospital characteristics. The adjusted OR of 24-hour deaths increased with increasing patient age. Patients with six or more rib fractures were three times more likely to die within 24 hours after admission than patients with only 1 rib fracture (OR, 3.16; 95% confidence interval [CI], 1.18 to 8.51). The odds of 24-hour death for those patients experiencing hemopneumothorax (OR, 3.15; 95% CI, 2.33 to 4.27), extremity fractures (OR, 1.74; 95% CI, 1.38 to 2.20), pelvis fractures (OR, 2.92; 95% CI, 2.06 to 4.14), head injuries (OR, 4.29; 95% CI, 3.49 to 5.27), spleen injury (OR, 1.83; 95% CI, 1.13 to 2.97), hepatic injury (OR, 4.39; 95% CI, 3.09 to 6.24), heart injury (OR, 4.48; 95% CI, 2.02 to 0.98), or diaphragmatic injury (OR, 3.16; 95% CI, 1.15 to 8.65) were higher compared with patients who did not, after adjusting for other factors and clustering effect among particular hospitals. Interestingly, patients treated in regional hospitals were 1.30 times more likely to die within 24 hours than patients treated in district hospitals.

Comment

In the modern era, motor vehicles are widespread and the incidence of traffic continues to rise. Rib fractures have been reported as the most common disorder associated with chest trauma, and almost 70% of these patients were hospitalized [7–9]. Our study explored the risk factors associated with 24-hour mortality after blunt chest trauma with fractured ribs resulting from motor vehicle accidents. We found that a total of 827 patients (4.4%) with traumatic rib fractures died within 30 days and 459 of these (55%) died within 24 hours. This is consistent with findings by Acosta and coworkers [5], who reported that 70% of trauma patients died within the first 24 hours after admission.

In human populations, men are usually more active and are injured more frequently than women, even in different countries or cultures. Liman and coworkers [8] in Turkey reported 1,053 men (70.6%) among 1,490 patients with blunt chest injuries; Bergeron and associates [10] in Canada showed 268 men (66.1%) among 405 patients with rib fractures; Kulshrestha and colleagues [11] in Massachusetts documented that 1,359 chest trauma patients included 964 male (70.9%) and 395 female (29.1%) patients. Consistent with the above reports, this study also shows that male patients account for 70.1% of all sampled patients in this category, although there is no difference in 24-hour mortality between sexes.

The higher mortality rate among the elderly (≥65 years of age) found by our study is consistent with the reports by Sirmali and colleagues [9] and Bergeron and coworkers [10]. However, the report by Bergeron and associates [10] recorded that 72% of ensuing mortality occurred more than 72 hours after admission and was associated with pneumonia in older patients, whereas our study recorded deaths within 24 hours only. Our findings suggest the elderly have a higher risk of death even immediately after a motor vehicle accident.

We found that increasing numbers of fractured ribs are associated with a higher percentage of comorbidities (not shown in the tables). Our finding is in agreement with a study by Sirmali and associates [9], which also reported a relationship between number of fractured ribs and increased complication rates. In addition, Kulshrestha and colleagues [11] concluded that more than five rib fractures was adversely related to mortality after chest trauma. We likewise found that 24-hour mortality is associated with increased number of fractures. In particular, patients with six or more rib fractures had more than three times the odds of 24-hour mortality than patients with only one rib fracture.

Blunt thoracic injury is almost always caused by the rapid deceleration of crashing in motor vehicle collisions. The pattern of injury sustained from direct impact may include fracture of the sternum, scapula, or vertebral column with hemothorax, pneumothorax, or both; anterior flail chest with cardiac and pulmonary contusion; fracture of extremities or pelvic or head injuries; and rupture of liver, spleen, or diaphragm. In the current study, head injuries (including fracture of skull or facial bones, cerebral laceration and contusion, and intracranial hemorrhage) occurred in 25.4% of patients. In addition, similar to the 20% reported by Kulshrestha and coworkers [11], we found 24.6% of the sampled patients sustained hemothorax or pneumothorax. And in our study, 14.6% of traumatic rib fractures were associated with fractures of the extremities. These three leading associated injuries all were associated with increased 24-hour mortality.

Kulshrestha and associates [11, 12] found an incidence of 1.5% to 6% of cardiac injuries among chest trauma patients in a single unit. In our series, the occurrence of cardiac injuries (0.4%) was far lower. Their sampled patients were selected from a single trauma center, which was more likely to admit severely ill patients in contrast to the nationwide population-based sample used in our study.

Diaphragm injuries increased the 24-hour mortality rate among patients with traumatic rib fractures, but the incidence was only 0.2% in our study—lower than the incidence of 2.3% to 5% reported in the literature [11, 13]. Reporting the incidence of cardiac and diaphragm injuries associated with chest trauma is not common and is usually reported by a single center [11–13]. The lower incidence found by our study may be explained by the fact that we used nationwide population-based data rather than data from a single medical center. In our study, patients with traumatic rib fractures associated with heart injuries, hepatic injuries, and head injuries and those who were older than 74 years of age initially had more than four times the mortality rate once a traffic accident happened. These seem to be the four leading factors causing death within 24 hours of admission.

Usually, flail chest is a serious problem in patients with rib fractures and has been associated with 11% to 40% mortality rate [9, 14–16]. Flail chest causes paroxysmal chest movement and respiratory insufficiency and may lead to subsequent death. Among the 66 patients with flail chest in our study, 2 (3%) died within 24 hours after admission and 26 (39.4%) were managed with mechanical ventilation. Eighteen (69.2%) of these 26 patients had continuous mechanical ventilation for 96 consecutive hours or more. Our data also showed the patients with flail chest did not have an increased 24-hour mortality rate. This suggests patients with traumatic rib fractures and flail chest have no higher mortality rate than those without flail chest in the initial 24 hours after a traffic accident. In addition, patients with traumatic rib fractures associated with fractures of the vertebral column or sternum did not have increased odds of 24-hour death. Interestingly, the patients with scapula fractures had a significant lower mortality rate in the first 24 hours. Scapular fractures may indicate the majority of the force of the traffic accident impacted the patient's back with the scapula absorbing part of the force and protecting visceral organs, accounting for lower initial rates of death.

In Taiwan, the northern district has the most abundant health-care resources compared with other areas, especially the eastern region (accounting for only 2.6% of all patients). In our study, hospital location was not related to 24-hour mortality rate. In addition, the patients sent to medical centers had a lower 24-hour mortality rate than those sent to regional hospitals. But patients sent to district hospitals had also a lower 24-hour mortality rate than those sent to regional hospitals. "Prehospital selection" may explain this pattern. In Taiwan, the drivers of emergency vehicles and emergency-care system staff, as well as families, may avoid sending patients with obvious severe injuries to district hospitals, with the result that fewer severely injured patients end up at district hospitals than regional hospitals, accounting for their lower 24-hour mortality rate.

It is also worth noting the effects of helmets, seat belts, and air bags on reducing risk of traumatic injury in motor vehicle accidents [17]. Although air bag deployment may increase the risk of upper and lower extremity injuries during traffic accidents [18–20], air bag deployment is associated with approximately 25% to 30% mortality reduction [21, 22]. Information regarding vehicle types, use of seat belts, and deployment of air bags was unavailable in our data set. However, most cars in Taiwan are equipped with air bags. The law also stipulates an NT$1,500 fine (about 50 US dollars) if a driver or front-seat passenger does not have the seat belt fastened. During the past decades, seat belts and air bags are considered to be significant contributors to the decreasing trend of mortality from motor vehicle collisions in some countries [17]. Furthermore, the mandatory motorcycle helmet law was implemented in Taiwan since 1997. Helmets were found to significantly reduce the number of motorcycle-related head injuries by 33% [23] and lead to a 71% reduction in the risk of death caused by head and neck injuries [24].

A particular strength of this study is the use of two nationwide population-based data sets, allowing us to trace medical services received by sampled patients after traffic accidents. However, our findings need to be interpreted within the context of three limitations. First, patients with severe injuries would be admitted and treated in hospitals. However, each hospital may have different criteria for patient admission. Second, the comorbidity diagnoses, which rely totally on claims data reported by physicians or hospitals, may be less accurate than if all individuals were assessed through a single standardized procedure. Finally, information regarding type of vehicles, and seat belt and air bag use, as well as numbers of patients ejected or extricated from vehicles, was not available in the claims data set. The severity of organ injuries was not graded owing to the lack of such information in the current coding system of ICD-9.

We conclude that heart injuries, hepatic injuries, head injuries, and advanced age are the most important determinants of 24-hour mortality after traumatic rib fractures as a result of motor vehicle accidents. The presence of hemothorax or pneumothorax, fractures of the extremities, pelvis fractures, spleen injuries, diaphragm injuries, or more than six ribs fractured also increased the risk of 24-hour mortality after chest trauma. A true profile of mortality associated with traumatic rib fractures should be useful for increasing efficacy of the emergency rescue system. Our study supplies a guide for identifying those at highest risk of death immediately after traumatic rib fractures as a result of motor vehicle accidents, allowing medical personnel to concentrate on these patients to improve the treatment outcomes.

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