

Trauma

Emergency air medical services for patients with head injury

Shin-Han Tsai, MD, PhD^{a,b,c}, Wan-Lin Chen, MD^{c,d},
Che-Ming Yang, MD, JD^e, Li-Hua Lu, MD, MPH^{c,f},
Ming-Fu Chiang, MD, PhD^g, Long-Jin Chi, MD^h, Wen-Ta Chiu, MD, PhD^{a,b,c,*}

Departments of ^aNeurosurgery, ^bEmergency and Critical Care Medicine, and ^cInstitute of Injury Prevention and Control,

Taipei Medical University and Wan Fang Medical Center, Taipei 110, Taiwan

^dDivision of Neurosurgery, Taipei City Hospital Renai Branch, Taipei 106, Taiwan

^eInstitute of Health Care Administration, Taipei Medical University, Taipei 110, Taiwan

^fDepartment of Emergency Medicine, Tongs' Taichung Metro Harbor Hospital, Taichung 435, Taiwan

^gDepartment of Neurosurgery, Mackay Memorial Hospital, Taipei 104, Taiwan

^hInternational SOS, Taipei 104, Taiwan

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Abstract

Background: Patients suffering head injury in remote islands of Taiwan, which have a shortage of manpower and facilities, depend on EAMS for prompt and definitive treatment. Emergency air medical services are becoming an increasingly important issue in improving the quality of primary care and avoiding medicolegal problems. The purpose of this study was to investigate the characteristics of patients with head injury and use of EAMS.

Methods: We reviewed all patients, especially head injury victims transported by air ambulance from a remote island, Kinmen (400 km from Taiwan Main Island), from January 2001 to December 2003. Data were collected with regard to demographics, disease classification, mechanism of injury, severity of head injury, ventilator use, and mortality rate.

Results: A total of 215 patients were transferred, of whom 57 (27%) had head injury. The mean age of patients was 48.6 ± 23.8 years. Males accounted for 72% of the cases (male/female ratio, 2.6:1). Motor-vehicle accidents were the most common mechanism of injury (68%). There were 21 (37%), 20 (35%), and 16 (28%) patients in the minor, moderate, and severe head-injury groups, respectively. Nineteen patients (33%) received mechanical ventilation. The overall mortality rate was 14% (8/57). In the severe head-injury group, the mortality rate was 44% (7/16).

Conclusions: The higher incidence of head injury (26.5%) in EAMS than in ground transportation (19.8%) suggests that preflight assessment and in-flight management of patients conducted by an experienced escort team following guidelines for head injury in EAMS are a very important issue. © 2006 Elsevier Inc. All rights reserved.

Keywords:

Head injury; Emergency air medical services; Ventilator; Remote island

Abbreviations: EAMS, emergency air medical service; EMS, emergency medical service; EMT-P, emergency medical technician-paramedic; GCS, glasgow coma scale; NTD, new Taiwan dollar; SOP, standard operating procedure.

* Corresponding author. Institute of Injury Prevention and Control, Taipei Medical University, Taipei 110, Taiwan. Tel.: +886 2 27390217; fax: +886 2 27390387.

E-mail address: wtchiu@tmu.edu.tw (W.-T. Chiu).

1. Introduction

Traumatic brain injury is the leading cause of death and disability among all traumas in Taiwan [6,7]. Annually there are 200 cases of head injury per 100 000 persons in the United States. The mortality rate of head injury in various countries ranges from 16.9% to 44% [4]. The mortality of head injury in Taiwan accounts for approximately 28% of all accidents [7]. As regards the incidence rate of head injury, Taiwan has a much higher rate than most other

countries. One of the major reasons is that the motorcycle is the most popular transportation vehicle in Taiwan.

According to previous studies by this institute, the incidence rate of head injury in the offshore islands of Taiwan is much higher than that in most developed countries [8,15]. Management of patients with head injury in the offshore islands of Taiwan depends on EAMS because of geographic limitations. The area of this study focuses on Kinmen, an island 400 km away from Taiwan Main Island (Fig. 1). Kinmen is separated by the Taiwan Strait and has a population of 58933 [3]. Medical facilities and manpower are inadequate as compared with Taiwan Main Island.

However, Kinmen has been developing rapidly because of tourism between China and Taiwan since the implementation of the “mini three links” in 2001. According to the statistics from the Tourism Bureau of Kinmen County at the time, the monthly number of domestic tourists was estimated to be more than 3000. It reached more than 420000 including tourists from both China and Taiwan in 2002 [2]. Unfortunately, there is a lack of neurosurgeons, emergency and critical care physicians, and facilities for management of patients with head injury. Patients who have either a major illness or trauma have to be transferred to Taiwan Main Island for further evaluation and management [21].



Fig. 1. Geographic location of Kinmen (circled on the left) and its relationship with Taiwan Main Island.

Table 1
Demographic data of all EAMS

		N = 215 (%)
Sex	Male	146 (67.9)
	Female	69 (32.1)
Mean age (y)	48.6 ± 23.8	
Age distribution (y)	0-15	16 (7.4)
	16-30	38 (17.7)
	31-45	35 (16.3)
	46-60	45 (20.9)
	61-75	54 (25.1)
	75-90	24 (11.2)
	>90	3 (1.4)
Disease category	Major illness	141 (65.6)
	Trauma	74 (34.4)

Investigations on EAMS of patients with head injury from a remote district, such as an offshore island, are scarce in this country as well as in other countries. The purpose of this study was to investigate the characteristics of patients with head injury in EAMS.

2. Methods

This is a retrospective study conducted from January 2001 to December 2003 analyzing all patients, especially patients with head injury, transferred by a fixed-wing aircraft (Fokker 50). The SOPs of transport are described as follows. (1) The medical flight crew consists of a physician, a flight nurse, and an EMT-P. All of them have good experience in critical care and emergency medicine. (2) Emergency air medical services requested by a local physician are based on the mechanism and severity of the injury (3) The management of the patient during ground and air transport follows the guidelines of the American College of Critical Care Medicine [13] and the Brain Trauma Foundation [19]. (4) The time en route to arrival at the trauma center is approximately 2 hours, and all flight missions are completed within 6 to 8 hours upon request.

The patients' demographics, causes of injury, disease classification, and GCS scores were collected. The severity of head injury was defined as follows: minor GCS: 14 to 15; moderate GCS: 9 to 13; and severe GCS, less than 8.

Further analysis was made on oxygen use, ventilator use, interventions performed, and the mortality rate. Data were

Table 2
Demographic data of patients with head injury

		n (%)
Sex	Male	41 (71.9)
	Female	16 (28.1)
Mean age (y)	46.7 ± 21.3	
Age distribution (y)	0-15	3 (5.3)
	16-30	10 (17.5)
	31-45	11 (19.3)
	46-60	15 (26.3)
	61-75	13 (22.8)
	76-90	5 (8.8)
Total	N = 57 (100)	

Table 3
Mechanism of injury and distribution of neurosurgical severity

	GCS	
	n	%
Mechanism		
Motor-vehicle accident	39	68.4
Fall	15	26.3
Attempted suicide	2	3.5
Gunshot	1	1.8
Total	57	100
GCS		
14-15	21	36.8
9-12	20	35.1
≤8	16	28.1
Total	57	100

analyzed using summary descriptive statistics with SPSS 11.5 (SPSS, Chicago, Ill).

3. Results

A total of 215 EAMS missions were performed from January 2001 to December 2003 on a fixed-wing aircraft (Fokker 50) from Kinmen. Among these 215 patients, 141 (65.6%) had a major illness and 74 (34.4%) had trauma (Table 1); of the 74 trauma patients, 57 (77%) had head injury. Therefore, head injury accounted for 74% (57/74) of trauma cases and 26.5% (57/215) of all EAMS cases.

In the head-injury group, the mean age of patients was 48.6 ± 23.8 years. Males accounted for 72% (41/57) of the cases (male/female ratio, 2.6:1). The patients' demographic data are summarized in Table 2. Motor-vehicle accidents were the most common mechanism of injury (68%). There were 21 (37%), 20 (35%), and 16 (28%) patients in the minor, moderate, and severe head-injury groups, respectively. The mechanism of injury and severity of head injury are listed in Table 3. Eighty-six percent (49/57) of patients used oxygen either because of a lack of cabin pressure in aviation (5000 ft) or for treatment for hypoxia. There were 19 patients (33%) who received mechanical ventilation (Uni-Vent Eagle Model 754, Impact Instrumentation Inc) and

Table 4
Interventions performed by flight medical crew

	n	Valid (%)
<i>Standard monitoring</i>		
Electrocardiogram	29	50.9
Pulse oximetry	53	93.0
Oxygen	49	86.0
Urinary catheter	23	40.4
Nasogastric tube	20	35.1
Fluid administration	56	98.2
<i>Advanced intervention</i>		
Blood transfusion	15	26.3
Inotropics	13	22.8
Resuscitation	2	3.5
Intubation	1	1.7
Extra intravenous lines	6	10.5

89% (51/57) of patients received osmotic diuretics, sedative, and anti-epileptic agent treatments. The types of intervention performed by the flight medical crew are summarized in Table 4.

Three patients with bilateral pupillary dilatation and loss of spontaneous respiration were not considered for air transport, since their families decided against heroic measures. One patient expired within 24 hours of admission to the receiving hospital and seven patients expired within 24 hours of admission. The mortality rate in the mild, moderate, and severe head-injury groups was 0% (0/21), 5% (1/20), and 44% (7/16), respectively. The overall mortality rate was 14% (8/57). There were no aviation incidents or medicolegal problems.

4. Discussion

With ground transport, the regular trauma-to-major illness incidence ratio in the emergency room ranges from 1:6.7 to 1:2.0. Head injury comprises about 60% of all trauma cases [11,12]. In the present study of EAMS, the incidence ratio of trauma-to-major illness was 1.9:1, and head injury accounted for 77% of cases of trauma in EAMS. However, in ground transportation, patients with head injury comprise only 59% of all cases. The higher incidence ratio of disease category (trauma-to-major illness) in EAMS demonstrates the major difference between EAMS and ground transportation. The higher incidence of head injury (26.5%) in EAMS than in ground transportation (19.8%) [11,12] suggests that the appropriate management of patients conducted by an experienced escort team following the guidelines for head injury in EAMS is a very important issue.

The age distribution of patients with head injury in the present study of EAMS was mainly in the middle-age group (Table 2). There were 33 (58%) patients older than 45 years. However, in Taiwan Main Island, the most prevalent age for head injury is in the young-age group (20–29 years old) [7]. The reason is that most of the young people in remote islands would like to go to cities for their career. People who are older than 65 years represent 12.8% of the Kinmen population, as compared with 9.2% in Taiwan Main Island. As for the sex ratio, there was a male predominance (male/female ratio, 2.6:1) in our study group, which is similar to that in ground transportation in major cities.

The most common mechanism of head injury in the present study was motorcycle accidents (68.4%). This is different from that in most Western countries, where falls or car accidents represent the most common mechanism of traumatic brain injury [16]. The major reason is that the motorcycle is the most popular transportation vehicle in both Taiwan Main Island and Kinmen.

The overall mortality rate of patients in this study (14.0%) was lower than that in most other reports with ground ambulance transport (13%–43%) [1,10,22]. The percentage of ventilator use is higher in this study (33%) compared with the ground transport group of critical patients (31%)

[1,5,10,22]. It is related to the ability of the escort team to manage patients more easily in the air. In a review of the literature, overall mortality is highest in patients transported by helicopter (35.7%), especially in trauma scene flight (prehospital transport) [17,20,23]. The lower overall mortality rate in our series compared with ground and helicopter transport may be attributed to the composition of the medical flight crew, in-flight monitoring, treatment given during evacuation, and type of aircraft. However, the mortality rate in the severe head-injury group (44%) in the present study is slightly higher than that in the ground transport group (38%–43%) [1,5,10,22]. Older age and the high percentage of severe injury in the present study may be related to higher mortality in the severe head-injury group.

Composition of the medical flight crew is an important part of EAMS. There have been cumulative reports suggesting that the experiences and capabilities of the medical flight crew were associated with patient outcome [9,14,17,18,22]. In the present study, all flights were staffed by a well-trained physician, nurse, and EMT-P to monitor the patient's condition and to perform interventions, especially in the air and in interhospital transportation of critically ill patients. The patient's condition is to be maintained or improved during the transfer. The escorting doctor should be aware of the differences between working in an airborne environment and in a static ground-based facility.

The mode of transport depends on clinical requirements, vehicle availability, and the conditions at the receiving sites. Helicopters are better used for emergency scene flight, with flight distance of less than 100 km. It is suggested that a flight range longer than 100 km is better transported by a fixed-wing aircraft. Several studies have questioned the safety of helicopter use by drawing attention to the limitations placed on flight crews, noise, vibration, and confined space limits [10,18,22]. For an adequate airborne medical care environment, the pressurized cabin provides controlled ambient pressure at high altitudes. This enables a high-speed, long-range, low-noise, and comfortable flight. The Fokker 50 aircraft belongs to Mandarin Airlines Company and is normally used for commercial domestic flight, especially between remote islands and Taiwan Main Island. It was used for EAMS as a chartered air ambulance with a stretcher fixed on the back of 10 seats. The cost of each flight including the fee for the escort team is NTD 450 000 (US\$13 500).

The limitation of this study is due to the fact that it was not possible to obtain an appropriate comparison population, and we could not compare the mortality of our patients with similar patients ground-transported and treated by EMS units. To the best of our knowledge, a similar series has not yet been reported in the literature.

5. Conclusions

Head injury is responsible for significant morbidity and mortality nationwide. The higher percentage of patients with

moderate and severe head injury and ventilator use indicates that a 24-hour alarm center and experienced physicians are necessary for EAMS of critically ill patients in remote islands. This study demonstrates the characteristics of patients with head injury in EAMS transported by a fixed-wing aircraft. This experience in transporting patients with head injury from a remote island to a major city may prove to be a good model for EAMS in other countries. Further efforts should be made to manage patients with head injury in EAMS.

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