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Original Article

Clinical Features and Required Aids of Transferred Severe Trauma Patients

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Background: It is crucial to identify the pivotal factors for transferring patients with major trauma. We aim to delineate the clinical features and required aids of severe trauma patients and identify the differences between those who were admitted directly to a trauma center and those transferred from other hospitals.
Methods: We retrospectively reviewed all hospitalized trauma patients discharged from the ward in Chi-Mei Medical Center from January 1, 2017 to December 31, 2018. Of 5,846 patients, we identified 1,061 patients with Injury Severity Score > 15, of which 92 patients were transferred from two branch hospitals (branch group), 172 patients were transferred from other hospitals (other group), and 797 patients were admitted directly through the emergency department (control group). We compared the clinical variables between control and the other two groups.
Results: The branch group included a high proportion of pediatric patients (control: 1.8%, other: 2.3%, and branch: 6.5%). The branch group demonstrated higher requirements for life-saving interventions and arterial embolization (branch vs. control, life-saving interventions: 26.1% vs. 17.6%, $p = 0.046$; arterial embolization: 9.8% vs. 3.5%, $p = 0.004$). However, no statistically significant differences were observed between the control group and other group in terms of requirements of life-saving interventions. The prognoses were similar between the groups.
Conclusions: Our trauma center can provide pediatric trauma care and timely life-saving interventions to help severe trauma patients transferred from other hospitals. The branch hospitals benefit mostly from the aid. Better network connection and information sharing between hospitals might play crucial roles in the management of transferred severe trauma patients.

Key words: *trauma, interhospital transfer, trauma center, characteristics, intervention*

Introduction

Transfer of patients with traumatic injury is influenced by several factors, including medical requirements, patients' preferences, and financial concerns.[1,2] Many kinds of research have proven the survival benefit of transferring patients with major trauma to tertiary trauma centers.[3-5] However, a systemic review indicated no difference in mortality between transfer and direct admissions of trauma patients.[6] We believe that certain patients may benefit from the interhospital transfer. However, it is essential to identify the pivotal factors for transferring patients with major trauma. These factors might be distinct in different states or medical systems.

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The management of patients with major trauma in emergency departments (EDs) requires rapid and resolute decisions. Emergency physicians and trauma surgeons should be able to recognize available resources to transfer patients appropriately. In addition to the capacity of their hospital, they must be aware of the interhospital resources of the local healthcare system, which could help them make wise decisions. We aim to delineate the clinical features and required aids of severe trauma patients and analyze the differences between those who were admitted directly to a trauma center and those transferred from other hospitals in Tainan City, with possible applicability to other regions.

Methods

This study was reviewed and approved by the Institutional Review Board of Human Research, Chi-Mei Medical Center. We used an in-hospital trauma registration system that collected data from all hospitalized trauma patients in Chi-Mei Medical Center to conduct this retrospective study. From January 1, 2017, to December 31, 2018, of 5,846 hospitalized trauma patients, we identified 1,061 patients whose Injury Severity Score (ISS) was > 15. Of the 1,061 patients, 797 were admitted directly through the ED (control group), 92 patients were transferred from two branch hospital (branch group), and 172 patients were transferred from other hospitals (other group). The flowchart of this case review is given in Fig. 1, and the geographic distribution of the other group is shown in Fig. 2. In Tainan City, there are two branch hospitals affiliated to Chi-Mei Medical Center. The

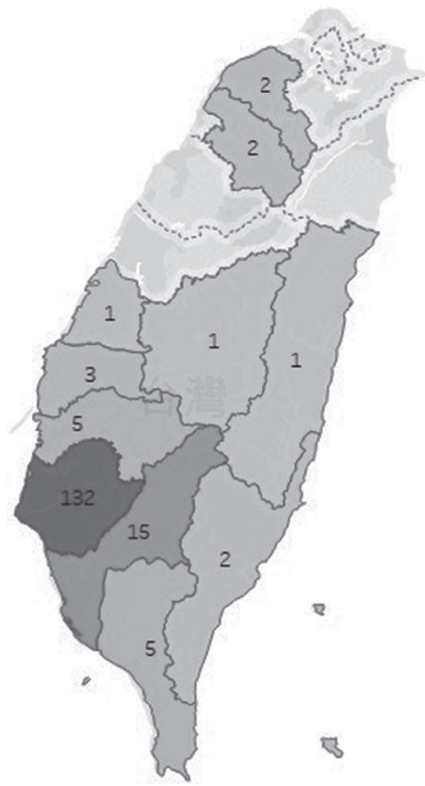

Fig 2. Geographic distribution of the other group.

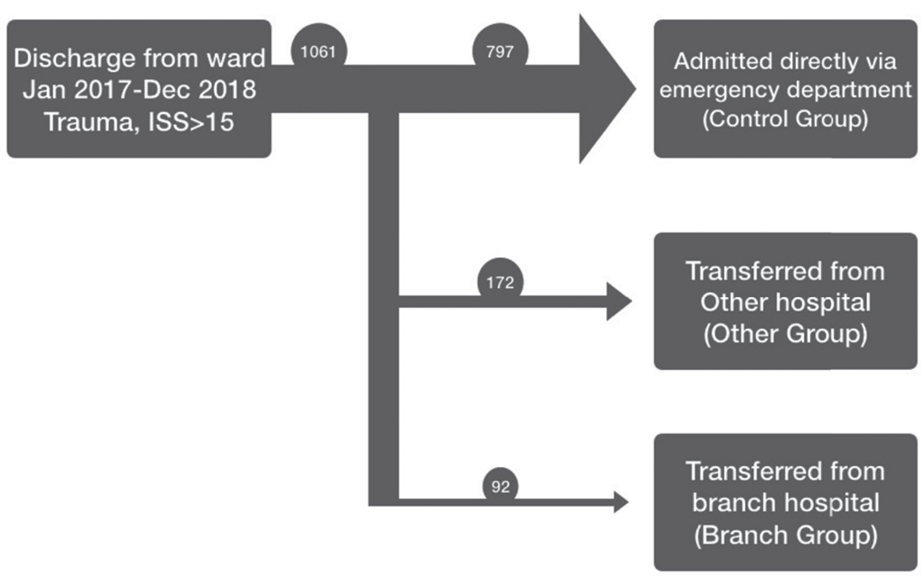

Fig 1. Flowchart of case inclusion.
ISS: Injury Severity Score.

emergency physicians routinely rotate among the EDs of branch hospitals and Chi-Mei Medical Center, and the three hospitals use the same information system. For the healthcare workers in this Chi-Mei system, it is easier to communicate and share medical details online.

We collected clinical data including age, sex, pediatric population (age < 15 years), comorbidities (included all pre-existing diseases listed on the patients' medical records), requirements for regular and emergent surgery, requirements for transarterial embolization, ISS, New Injury Severity Score (NISS), Revised Trauma Score (RTS), Trauma Injury Severity Score (TRISS), length of stay in hospital, length of stay in intensive care unit (ICU), complications, mortality, and requirements for chronic care of these patients (Table 1).

Statistical analyses were performed using SPSS 15 (SPSS Inc., Chicago, IL, USA). Continuous data are presented as mean ± standard deviation. We applied Fisher's exact test to evaluate differences in the categorical variables and the Student's t test to evaluate differences in the continuous variables between control and the other two groups. A two-tailed p value of 0.05 was considered statistically significant for all comparisons.

Results

General Description

All three groups demonstrated a predominance of male patients, and the control group showed a higher proportion of female patients than the other two groups. Regarding age, the branch group had younger patients than the control group had (control group: 54.3 ± 21.3 years, branch group: 47.6 ± 23.7 years, other group: 50.3 ± 21.8 years). The differences in age distribution can be attributed to the higher transfer rate of pediatric patients in the branch group (control group: 1.8% vs. branch group: 6.5%, p = 0.004; vs. other group: 2.3%, p = 0.616). The comorbidity rate of patients in the control group was similar to that of patients in the other group (43.2% vs. 41.9%, p = 0.754) and was higher than that of patients in the branch group (43.2% vs. 31.5%, p = 0.032). Among the groups, the control group demonstrated the lowest trend of triage (control group: 2.1 ± 0.7 years, branch group: 1.7 ± 0.6 years, and other group: 1.8 ± 0.7 years). However, the differences between the groups were statistically non-significant. Concerning the injured body parts, different groups demonstrated different injury patterns. The control group exhibited the highest proportion of head and neck injuries. The branch group presented with the most chest, abdomen,

Table 1. Comparisons of demographic variables, trauma scores, and hospital courses between the branch group and control group and the other group and control group[a]

	Control	Branch	p	Others	p
Age	54.3 ± 21.3	47.6 ± 23.7	0.030	50.3 ± 21.8	0.583
Male	63.6	73.9	0.051	73.3	0.016
Pediatric (< 15-year-old)	1.8	6.5	0.004	2.3	0.616
Comorbidity	43.2	31.5	0.032	41.9	0.754
Triage	2.1 ± 0.7	1.7 ± 0.6	0.421	1.8 ± 0.7	0.357
Injury Severity Score (ISS)	22.1 ± 9.4	22.7 ± 7.6	0.679	22.2 ± 8.8	0.552
New Injury Severity Score (NISS)	25.9 ± 9.0	26.0 ± 9.3	0.713	25.9 ± 9.2	0.910
Revised Trauma Score (RTS)	7.2598 ± 1.2057	6.9070 ± 1.4440	0.000	7.0605 ± 1.3519	0.010
Trauma Injury Severity Score (TRISS)	0.8725 ± 0.1969	0.8544 ± 0.2107	0.239	0.8518 ± 0.2270	0.017
Requirements for surgery[b]	42.7	56.5	0.011	45.3	0.518
Requirements for ICU	61.7	71.7	0.060	66.3	0.264
Hospital stay (days)	15.9 ± 17.1	19.9 ± 19.5	0.069	19.1 ± 19.8	0.214
ICU stay (days)	8.7 ± 10.8	11.7 ± 13.1	0.002	8.9 ± 8.1	0.230

[a]Data are presented as mean ± standard deviation or percentage (%).
[b]Requirement of surgery consists of patients requiring any surgery during admission, including emergent, urgent, or regular operations.
ICU: intensive care unit.

and external injuries (mostly were burn injuries). The other group showed the most chest, extremities, and external injuries (Fig. 3).

Severity

No statistical difference was observed in ISS and NISS between the control and branch groups and between the control and other groups. Compared with the control group, both branch and other groups showed lower RTSs (control group: 7.2598 ± 1.2057 vs. branch group: 6.9070 ± 1.4440, p = 0.000; vs. other group: 7.0605 ± 1.3519, p = 0.010). The control group demonstrated TRISSs similar to those of the branch group and higher TRISSs than the other group (control group: 0.8725 ± 0.1969 vs. branch group: 0.8544 ± 0.2107, p = 0.239; vs. other group: 0.8518 ± 0.2270, p = 0.017).

Interventions

Compared with patients in the control group, a higher percentage of patients in the branch group required emergent surgery (branch group: 56.5% vs. control group: 42.7%, p = 0.011). The requirements for surgery in the other group were comparable with that in the control group (Fig. 4). Patients in the branch group required more life-saving interventions (including transarterial embolization and emergent surgery) than those in the control group (branch group vs. control group: all life-saving interventions: 26.1% vs. 17.6%, p = 0.046; transarterial embolization, 9.8% vs. 3.5%, p = 0.004; emergent surgery: 16.3% vs. 14.1%, p = 0.559). No statistical differences were observed between the control group and other group for requirements of life-saving interventions.

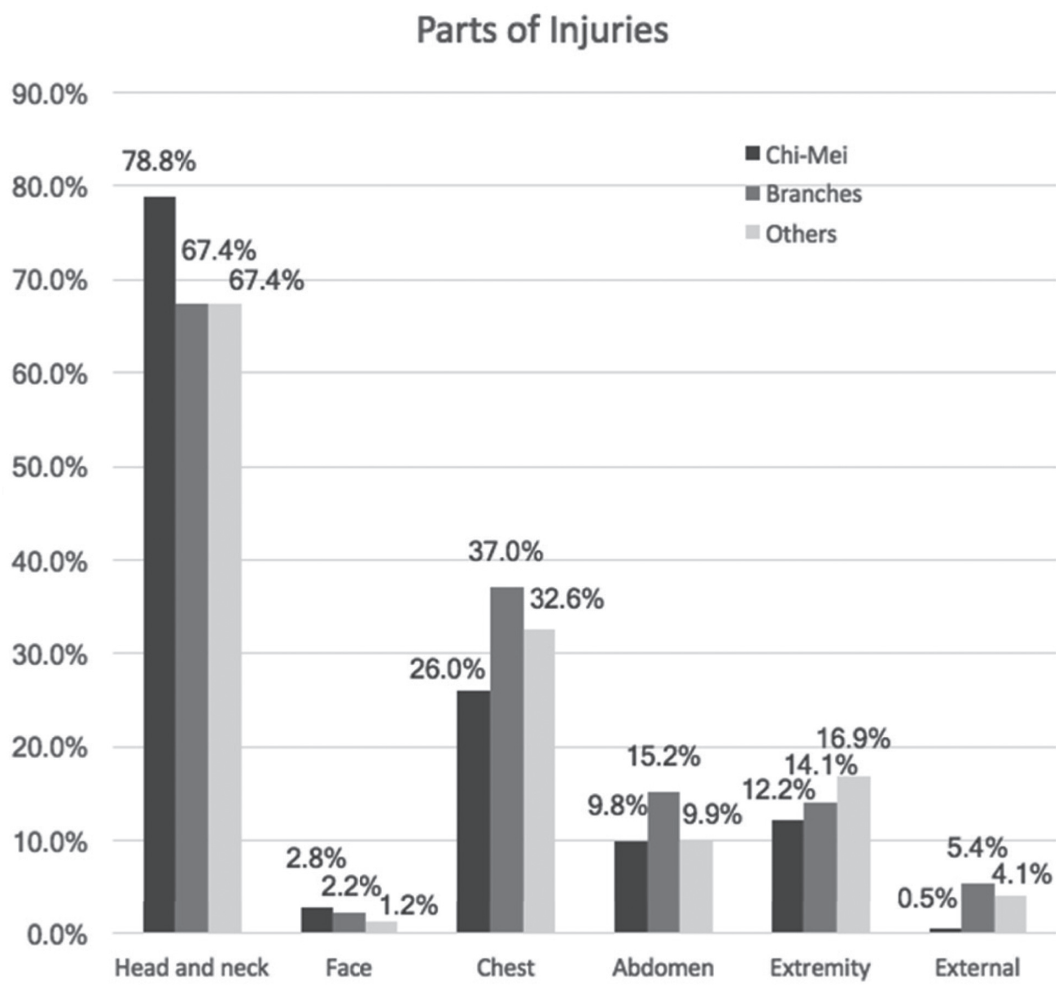

Fig. 3. Injured body parts in the different groups.
The injured body part with abbreviated injury score ≥ 3 in each case. The three groups exhibit different injury patterns.

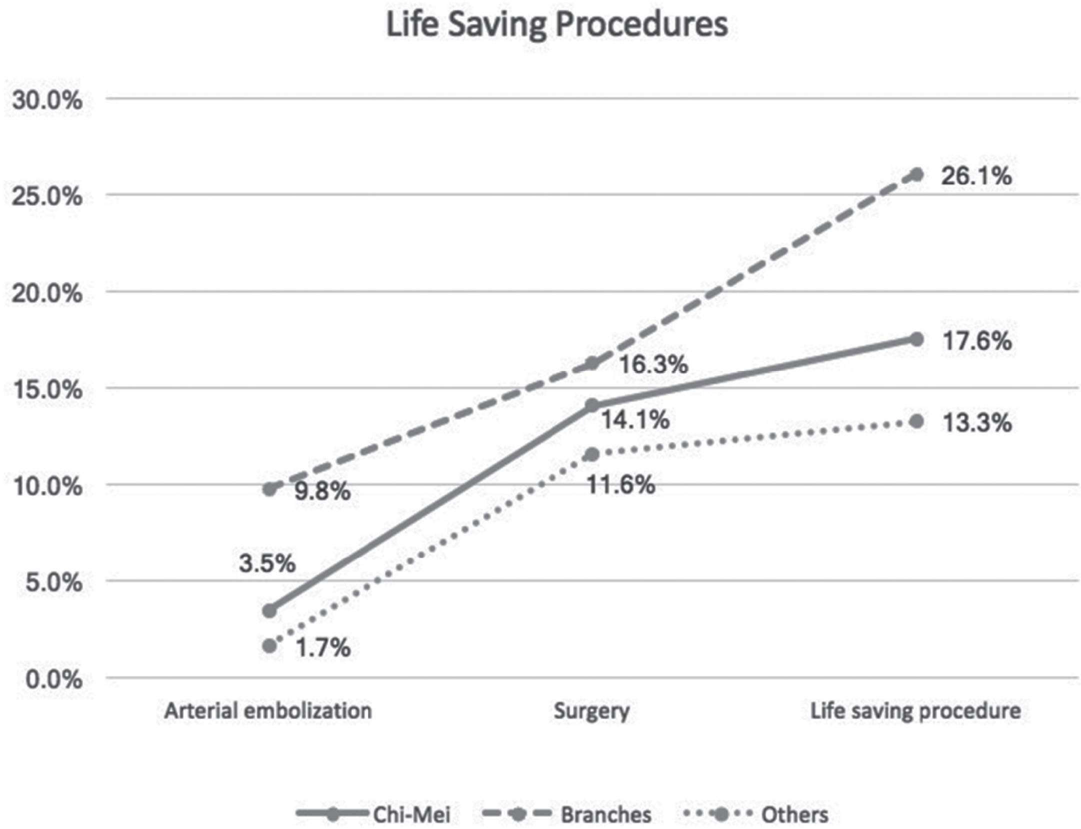

Fig 4. Life-saving procedures in different groups.

Life-saving procedures include arterial embolization and emergent surgery. The branch group demonstrates significantly high demand for all life-saving procedures and surgery and a high trend of arterial embolization. However, the other group shows a lower trend in all these life-saving procedures.

Hospitalization and Prognosis

In comparison with the control group, branch and other groups demonstrated comparable requirements for intensive care and similar lengths of hospital stays (requirements for ICU: control group 61.7% vs. branch group 71.7%, $p = 0.060$; vs. other group 66.3%, $p = 0.264$; lengths of hospital stays: control group 15.9 ± 17.1 vs. branch group 19.9 ± 19.5, $p = 0.069$; vs. other group 19.1 ± 19.8, $p = 0.214$) (Fig. 5). Patients in the branch group stayed longer in the ICU than those in the control group (branch group 11.7 ± 13.1 vs. control group 8.7 ± 10.8, $p = 0.002$). The length of ICU stay was similar between the control group and other group. No statistical difference was observed in the incidence of complications (control group 15.4%, branch group 21.7%, and other group 19.2%) between the control group and the other two groups. The prognoses of all patients were divided into three categories: recovery, chronic care, and mortality. Compared with patients in the control group, those in the branch group and other group presented similar results of prognosis.

Discussion

Two of the branch hospitals in the Chi-Mei system provide partial pediatric emergent care only. One of the hospitals does not even have a pediatric ward. Accordingly, most pediatric patients with severe trauma would be transferred to other hospitals for further care. Chi-Mei Medical Center becomes the first choice of transfer because emergency physicians work under the same system and can share patients' information online before transfer. The higher percentage of pediatric patients in the branch group also explained the low age group and low incidence of comorbidities in the branch group.

Considering trauma severity, we discovered that all three groups showed similar ISS and NISS, which indicated that they presented with approximately similar trauma severity. It is common for trauma pa-

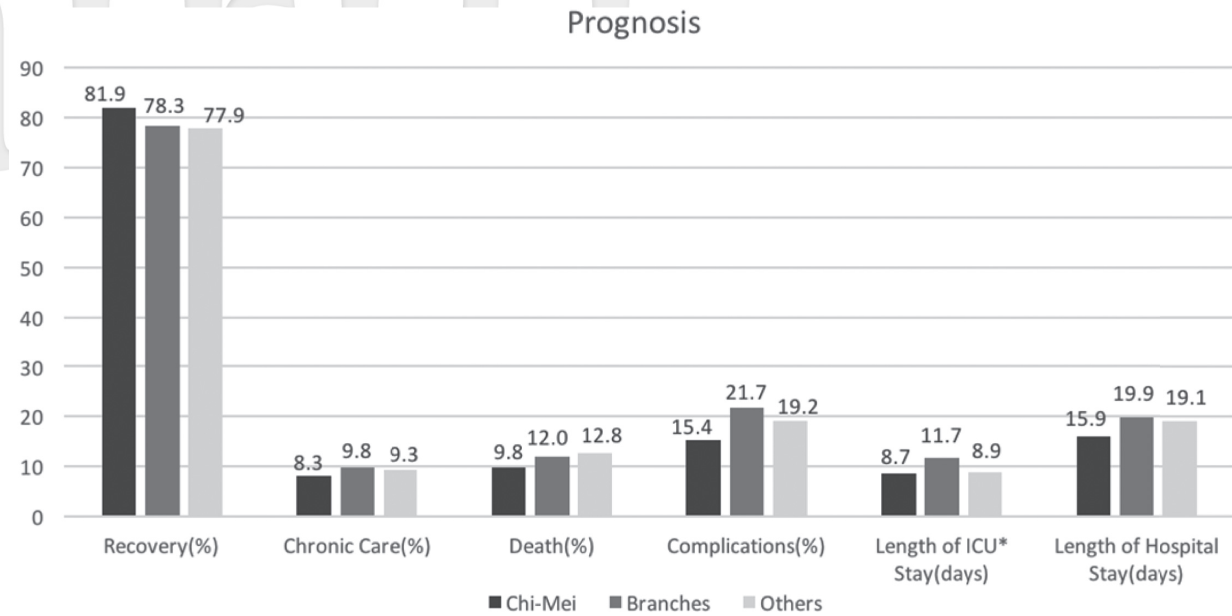

Fig 5. Outcomes of different groups.
No significant differences were observed between the three groups.
ICU: intensive care unit.

tients to deteriorate rapidly after arrival to the ED. By contrast, the patients transferred from other hospitals had undergone investigations, and most severe injuries had been identified before arrival to the next hospital. This may explain the trend of lower triage in the control group than in the other two groups. RTSs represent vital signs, including Glasgow Coma Scale, systemic blood pressure, and respiratory rate.[7] Lower RTS in patients of the branch and other groups inferred that these transferred patients were more unstable than patients in the control group. TRISS consists of the calculation of blunt/penetrating, ISS, RTS, and age.[8] In Tainan City, most trauma events are blunt injuries. Low RTS contributed to a low TRISS in the control group. In the branch group, younger age balanced the lower RTS, which resulted in statistically non-significant differences in TRISS.

Before transfer a patient with major trauma, the antecedent hospital usually will discuss the feasibility of performing urgent life-saving interventions with the next hospital. However, most hospitals cannot share all the patient's information with other hospitals, many transfers will fail because it is difficult to determine whether the patient requires an urgent life-saving intervention. Patients in the branch group presented with more requirements for life-saving interventions, which demonstrated the importance of sharing medical information and authentic communication between both sides of the transfer. If the detailed information of a wounded patient can be delivered from the first-aid hospital to the trauma center accepting the patient, the trauma center can clearly declare the type of resources available, and patients with severe trauma can avoid unnecessary transport and will benefit from the interhospital transfer. Despite the increment of surgery and transarterial embolization in the branch group, the prognosis of patients in this group remained comparable with those in the control group, which proved the transfers of these patients were essential and life-saving. This phenomenon also indicates the importance of interhospital communication before the transfer of trauma patients.[9]

Patients in the other group showed less demand for life-saving interventions, which implies that a part of the transfer is based on regional or nonmedical factors. This group had the highest number of extremity and external injuries, which were less likely to deteriorate within a short posttraumatic period than head or torso injuries. However, notably, lower RTSs in the other group were attributed to lower Glasgow Coma Scales and systemic blood pressures of this group than the control group, which cautions emergency physicians and trauma surgeons that interhospital transfer is still risky for severe trauma patients.

Faul et al. reported a high rate of traumatic brain injury hospitalization in a nontrauma center,[10] which is in accordance with the findings of this study. The patients' residential location, current medications, as well as the preference of patients and their families are all crucial factors for the decision to transfer patients with traumatic brain injury.

Additionally, the incidence of transfer for patients with severe burn injuries was high in both the branch and other groups. The current guideline for burn injury suggests that appropriate treatment of severe burns can only be conducted in a trauma center.[11] Therefore, these patients were transferred to Chi-Mei Medical Center.

Limitations

This research has all the inherent limitations of a retrospective study. First, a preset protocol for transferring patients with severe trauma is lacking. Some patients were transferred after an authentic mutual agreement between the two hospitals, and some patients arrived at the ED of Chi-Mei Medical Center without any formal connection. The differences among these patients may alter the management and prognosis. Second, the classification of patients is based on the Abbreviated Injury Scale. This simple classification system might overlook the damage and benefit of certain rare injuries. We will conduct a further prospective study on these prominent categories. Third, many hospital factors (such as the care in ED, in ward, and in ICU) may alter the prognosis of patients, and these factors varied in different hospitals. Some patients had been treated in antecedent hospital for a few days and some patients were transferred to Chi-Mei Medical Center soon after arrival. These hospital factors may have different influences on different patients. Finally, the prognosis of patients is derived from the conditions of patients during discharge. Long-term outpatient's follow-up may provide different results.

Conclusions

Our trauma center can provide pediatric trauma care and timely life-saving interventions, especially arterial embolization, to treat trauma patients transferred from other hospitals. The branch hospitals mostly benefit from the aid. Better network connection and information sharing between hospitals might play crucial roles in the management of transferred patients with severe trauma.

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