

Evaluation of the Effects of Standard Rescue Procedure on Severe Trauma Treatment in China

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Abstract

Background: This study aimed to evaluate the effects of standard rescue procedure (SRP) in improving severe trauma treatments in China.

Methods: This study was conducted in 12 hospitals located in geographically and industrially different cities in China. A standard procedure on severe trauma rescue was established as a general rule for staff training and patient treatment. A regional network (system) efficiently integrating prehospital rescue, emergency room treatments, and hospital specialist treatments was built under the rule for information sharing and improving severe trauma treatments. Treatment outcomes were compared between before and 1 year after the implementation of the SRP.

Results: The outcomes of a total of 74,615 and 12,051 trauma cases were collected from 12 hospitals before and after the implementation of the SRP. Implementation of the SRP led to efficient cooperation and information sharing of different treatment services. The emergency response time, prehospital transit time, emergency rescue time, consultation call time, and mortality rate of patients were 24.24 ± 4.32 min, 45.69 ± 3.89 min, 6.38 ± 1.05 min, 17.53 ± 0.72 min, and $33.82\% \pm 3.87\%$ ($n = 441$), respectively, before the implementation of the standardization and significantly reduced to 10.11 ± 3.21 min, 22.39 ± 4.32 min, 3.26 ± 0.89 min, 3.45 ± 0.45 min, and $20.49\% \pm 3.11\%$, separately ($n = 495$, $P < 0.05$) after that.

Conclusions: Staff training and SRP can significantly improve the efficiency of severe trauma treatments in China.

Key words: China; Procedure; Standard; Trauma; Treatment

INTRODUCTION

Trauma is a major public health problem worldwide. According to the report from the World Health Organization, about 5 million people in the world died of trauma in 2000, accounting for 9% of global deaths.^[1] A total of 500,254 road accidents occurred in China in 2010, causing 108,738 death and 5,069,911 injuries, property damage of 1.771 billion Chinese Yuan, and up to 65 billion Chinese Yuan of direct

medical costs.^[2] Young people, the major social labors, are the main victims of trauma, the caused death and disability have increasing impacts on society and economy losses, which brought a heavy burden to their families and the society.^[3,4]

China is currently the largest developing country in the world and has its own social and economic background. The vehicle holdings and the total length of the highway network have increased dramatically in China with the rapid development of the economy for nearly 30 years, causing the significant increase of traffic accidents and trauma. In addition, construction effects brought about by urbanization

Access this article online

Quick Response Code:



Website:
www.cmj.org

DOI:
10.4103/0366-6999.156768

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and increase of industrial and mining production also contributed greatly to the accidental injuries, which make the treatment of trauma patients facing unprecedented challenges in China.^[5] According to our previous study, the prominent problems of trauma rescue in China were as following: Too much prehospital time, no information linkage among prehospital, emergency room, and specialist treatment, and lack of standard rescue procedure (SRP)^[6] for trauma rescue.

In this study, we applied a SRP to improve severe trauma treatments in China. The treatments efficiency of severe trauma was compared before and after the implementation of the SRP in 12 hospitals in different cities in China. Our study evaluated the efficiency of current severe trauma treatment system and highlighted the national wide implementation of the SRP to improve severe trauma treatments in China.

METHODS

Selection of hospitals and cities

Twelve Chinese cities were selected and included in this study based on their geographic locations. These cities located in the south and east of the Chinese Heihe-Tengchong Line (Aihui-Tengchong Line),^[7] and have over 96% population of China. These cities include Changchun, Jinan, Hangzhou, Shenzhen, Hefei, Xi'an, Wuhan, Liuzhou, Tianjin, Tangshan, Dalian, and Jinzhou. A local general hospital was selected from each city for the implementation of the SRP of severe trauma treatment and consistent staff training.

Establishment and implementation of the standard rescue procedure of severe trauma treatment

The purpose of this SRP was to significantly shorten the rescue time and reduce the mortality rate of severe trauma. The SRP of severe trauma treatment was first established by a committee led by the Peking University Medical Center and participated by experts from other 10 top medical institutions in China. This SRP covers two major services, prehospital rescue and hospital treatments. The prehospital care includes on-site environment assessment, injury evaluation, determination of receiving hospital or trauma center, patient transit and information exchange with in-hospital teams, etc. The hospital treatment processes include evaluating the injury via the network prior to patient arrival, starting appropriate levels of preparation and alert, arranging appropriate staff, medical equipment, and medicine. Severe trauma treatment teams that conduct prehospital rescue, emergency room treatment, and hospital specialist treatments were then built up according to the SRP for severe trauma treatment. At the same time, an informative and regional network was built up to integrate different services including prehospital rescue, emergency room treatments, and hospital specialist treatments and allow them to share medical information of severe trauma patients [Figures 1 and 2].

Data collection and analysis

This study was conducted under the supervision of the Ethic Committee of Peking University People's Hospital. To obtain the general situation of severe trauma treatment in China, a

questionnaire was designed by the severe trauma treatment committee and used for the trained staff to collect severe trauma patients' information including general information such as gender, age, trauma classification, injury location of the body, medical rescue, and treatments time such as the emergency response time, prehospital transit time, emergency rescue time, and consultation call time, and outcomes of all patients between 2009 and 2012. After the implementation of the SRP of severe trauma treatment, the same questionnaire mentioned above was used to collect severe trauma treatments information of the patients for 1 year and to generate a table and compared with the current situation of severe trauma treatment in China to evaluate the effects of such SRP. Only patients with a definite diagnosis of trauma were included in the study sample. The diagnosis of trauma was determined as damage to human body caused by physical harm from an external source. We excluded all patients only with other disease or psychological trauma.

Chi-square test was used to compare the differences between traumatic injury sites and types before and after the implementation of the SRP of severe trauma treatment. In addition, we used Kolmogorov–Smirnov test to examine the normality and Levene's test to verify homogeneity of variance among the measurement data. They were expressed as mean \pm standard deviation and were conducted using an independent *t*-test. SAS statistical software (version 9.0; SAS Institute, Cary, North Carolina, USA) was used in statistical analysis. *P* < 0.05 was considered statistical significance.

RESULTS

Current situation and efficiency of severe trauma rescue and treatments in China

In this study, the data of a total of 74,615 and 12,051 cases of trauma and treatments were collected before and after the implementation of the SRP of severe trauma treatment in participated hospital. Among these cases, pediatric patients (0–12 years old), adolescent patients (12–18 years old), young patients (18–40 years), middle-age patients (40–

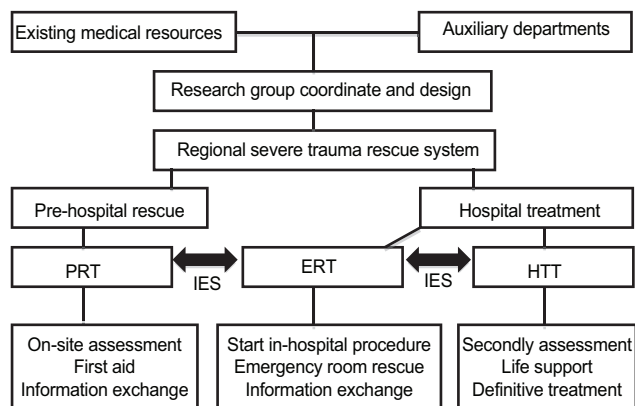


Figure 1: A regional severe trauma rescue system consists of three rescue teams including prehospital rescue team (PRT), emergency rescue team (ERT), and the in-hospital rescue team which were linked with an information exchange system for medical information sharing.

65 years), and old patients (>65 years) account for 2.05%, 2.63%, 33.24%, 52.83%, and 12.77%, respectively [Figure 3]. Injuries of head and face, upper and lower extremities were the most common trauma types and account of 79.7% [Table 1]. According to the injury types, trauma caused by traffic accidents is the most common (38.5%) [Table 2]. The Injury Severity Score (ISS) >16 trauma patients accounted for 21.09% of the total number of patients, including severe traffic trauma of 32.45%. In addition, the mortality rate of ISS > 16 patients was 33.82%. There was no significant difference of the characteristics of the collected cases between before and after the implementation of the SRP ($P > 0.05$) [Tables 1 and 2].

Implementation of the standard rescue procedure significantly improved severe trauma rescue and treatments

Test of normality and homogeneity of variance was conducted among all measurement data ($P > 0.10$). Before the implementation of the SRP, the average emergency response time of all hospitals was 24.24 ± 4.32 min and the longest emergency response time was 150 min. The average prehospital transit time for transiting trauma patients from injury sites to the emergency room of the hospital was 45.69 ± 3.89 min, with the longest of 181 min. The average emergency waiting time between the arrival of patients at the hospital and the start of treatments was 6.38 ± 1.05 min, with longest of 51 min. The average consultation waiting time between the consultation call and specialist arrival at the emergency room was 17.53 ± 0.72 min, with the longest of 54 min. After the implementation of the SRP of severe trauma treatment, compared to the original results, the average emergency response time, the average prehospital transit time, the average emergency waiting time, reduced significantly to

10.11 ± 3.21 min ($P = 0.018$), 22.39 ± 4.32 min ($P = 0.042$), and 3.26 ± 0.89 min ($P = 0.032$), respectively. The average consultation waiting time was reduced to zero ($P = 0.028$) because the hospital specialists were informed by the regional severer trauma treatment network, and they waited in the emergency room before the patients arrived at the

Table 1: Comparison of the injury sites of severe trauma patients before and after the implementation of standard rescue procedure of severe trauma treatment in China

Traumatic injury sites	Before, n (%)	After, n (%)	χ^2	P
Head and face	30,965 (41.5)	4977 (41.3)	8.74	0.19
Neck	2760 (3.7)	470 (3.9)		
Chest and back	1940 (2.6)	349 (2.9)		
Upper limb and shoulder	8058 (10.8)	1350 (11.2)		
Waist and pelvis	3805 (5.1)	578 (4.8)		
Lower limb	20,445 (27.4)	3278 (27.2)		
Others	6641 (8.9)	1048 (8.7)		
Total	74,615 (100.0)	12,051 (100.0)		

Table 2: Comparison of injury types of severe trauma before and after the implementation of standard rescue procedure of severe trauma treatment in China

Traumatic injury types	Before, n (%)	After, n (%)	χ^2	P
Traffic injury	28,726 (38.5)	4736 (39.3)	8.11	0.15
Violent injury	13,729 (18.4)	2193 (18.2)		
Fall injuries	13,281 (17.8)	2109 (17.5)		
Blunt injury	8058 (10.8)	1265 (10.5)		
Crush injury	6492 (8.7)	1000 (8.3)		
Others	4358 (5.8)	747 (6.2)		
Total	74,615 (100.0)	12,051 (100.0)		

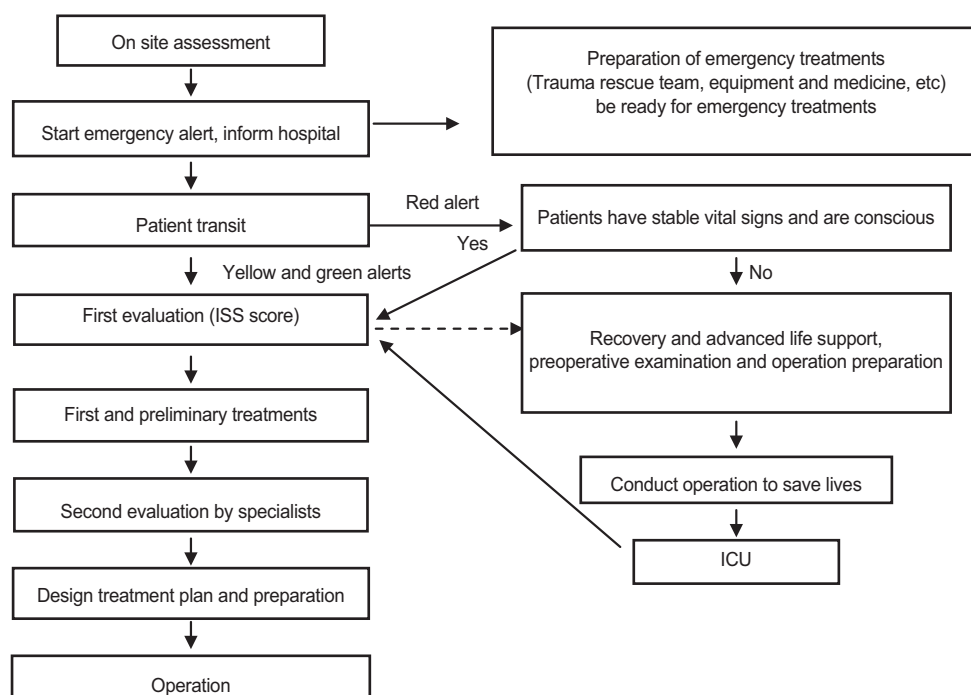


Figure 2: Standard rescue procedures of severe trauma treatment in China.

hospital. In addition, the in-hospital mortality rate of severe trauma decreased dramatically from 33.82% ± 3.87% to 20.49% ± 3.11% after the implementation of the SRP, with *P* value 0.037 [Table 3].

DISCUSSION

In this study, we evaluated the effects of the SRP in improving severe trauma treatments in 12 cities in China. These cities in China were selected based on distinct geographic and industrial characteristics, mainly represent the current situation of severe trauma treatments in China.^[8] We found that the efficient integration network and cooperation among different teams, between the prehospital teams and hospital physicians under the SRPs can greatly improve the outcomes of severe trauma patients.

No information linkage among prehospital, emergency room, and specialist treatment was one of the most important reasons for the low efficiency of trauma treatment in China.^[9,10] First, current prehospital severe trauma rescue in China is an independent model in which only the “120” emergency system is involved in most cities. It has independent manage system, staff, and equipment. The “120” emergency rescue staff only provides fast and preliminary treatments including bleeding, bandaging, fixing, and its major task is to transit trauma patients to the emergency room. As an independent medical unit, the “120” emergency system only arranges emergency staff and vehicles to the accident sites. Limited communication between the “120” emergency system and local hospitals usually leads to insufficient preparation in receiving hospitals. Usually, physicians in the emergency room start to assess the injury, arrange rescue staff and equipment, and request consultation

call only after the arrival of “120” emergency vehicle. All these drawbacks may prevent the severe trauma patients to be treated on time and may lead to serious outcomes. That was why current average emergency waiting time between the arrival of patients at hospital and start of emergency treatments was 6.38 min, with longest of 51 min.

Second, there are generally two types of emergency room in the hospitals in China, comprehensive emergency room and limited emergency room. The comprehensive emergency room referring to the department of emergency has independent operation room and postoperative care. The comprehensive emergency room can independently conduct diagnosis and treatment of severe trauma. The limited emergency room can only conduct emergency treatments of simple trauma, but consultation call for specialists is needed for treating severe trauma. Among the 12 hospitals included in our study, 10 has limited emergency room, which is common in most Chinese hospitals. Usually, specialists distribute in different departments in the hospital and are asked for help when severe trauma patients arrive at the emergency room. In addition, without efficient cooperation and management and information sharing, special physicians may not be available for severe trauma rescue and treatments because of being involved in other clinical work. Although the limited emergency room model saves medical resource, it definitely lead to delay of treatment of severe trauma. Our study demonstrated that the current consultation call time of the 12 hospitals in China was 17.53 min with the longest of 54 min, suggesting that the limited emergency room model is not efficient for severe trauma treatments. All these drawbacks extend the rescue time and thus limited the efficiency of severe trauma in China.^[5,11]

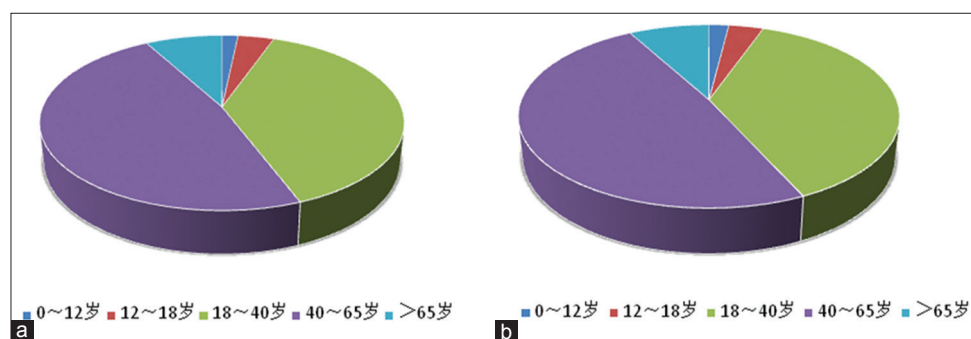


Figure 3: Comparison of the proportion of trauma patients of different ages before (a) and after (b) the implementation of standard rescue procedure of severe trauma treatment in China.

Table 3: Comparison of the treatment outcomes before and after the implementation of standard rescue procedure in severe trauma treatment in China (mean ± SD)

Outcomes	Before	After	Reduction	<i>P</i>
Emergency response time (min)	24.24 ± 4.32	10.11 ± 3.21	14.13 ± 2.16	0.018
Prehospital transit time (min)	45.69 ± 3.89	22.39 ± 4.32	23.30 ± 1.89	0.042
Emergency rescue time (min)	6.38 ± 1.05	3.26 ± 0.89	3.12 ± 0.63	0.032
Consultation call time (min)	17.53 ± 0.72	3.45 ± 0.45	12.53 ± 3.10	0.028
Mortality (%)	33.82 ± 3.87	20.49 ± 3.11	13.33 ± 2.51	0.037

t-test, **P*<0.05. SD: Standard deviation.

Lack of SRP for trauma rescue, inappropriate organization of prehospital rescue staff and the bad traffic condition might be other main reasons for the low efficiency of trauma treatment in China. The golden rescue time for severe trauma is the first 15 min after injury. The average emergency response time between the rescue call from patients and the arrival of emergency medical staff is an internationally recognized standard for the evaluation severe trauma rescue of a country. The average emergency response time in some countries that have a high level of severe trauma rescue including Germany, the UK and France, are 5, 6, and 10 min, respectively. Our results demonstrated that the average emergency response time in selected cities in China is 45.69 min with the longest time of 150 min. In addition, the average prehospital transit time for transporting patients from trauma sites to the emergency room of the hospital was 45.69 min, with the longest of 181 min. Both the average emergency response time and the average prehospital transit time are significantly longer than those in the developed countries mentioned above. With the rapid development of the economy, the motor vehicle holding in China has increased dramatically during the last 20 years, and reached to a total number of 200 million. However, the urban infrastructure facilities including road construction lagged behind, leading serious traffic congestion. On some main roads, the traffic speed is below 15 km/h during rush hours. More than 70% of Beijing's 4.8 million vehicles distribute within the 6th beltway, which is distinct from other big cities in the world in which per capita vehicle ownership is lower in the center of the city but gradually decrease to outside. The traffic congestion has great influence on severe trauma rescue.

With the assistance of local government, especially the local public health government, severe trauma treatments network has been established, and staff was trained to follow the SRP of severe trauma treatment. In addition, efficient cooperation and information and data sharing between the prehospital rescue team, the hospital emergency staff, and specialists were also achieved in this system.^[12-16] Based on our results, the time between injury occurrence and efficient treatment in the hospital was reduced from 91.07 min to 40.76 min after the implementation of SRP of severe trauma treatment. The in-hospital mortality rate of severe trauma patients was also reduced from 33.82% to 20.49% with the implementation of SRP. These data indicated that the implementation of the SRP of severe trauma treatment has positive effects on the treatment of severe trauma by efficiently integrating the prehospital emergency rescue and hospital treatments. The SRP of severe trauma treatment significantly improved onsite emergency rescue after the call for rescue was received by the severe trauma treatment network. In addition, sharing information of patients and treatments among different teams saved the time in every step of trauma rescue and also improved the treatment of severe trauma. However, due to the limitation of a retrospective study, it is inevitable that there may exist information bias and selection bias, which in turn may have some effects on the authenticity and integrity of the collected data. In future study, we should conduct the perspective cohort studies to make our results more convincing.

Overall, China is now still at the early stage of severe trauma treatment. Although a number of trauma rescue and treatment organizations have been established recently, the trauma rescue and treatment time is still too long, the survival rate is still low, and the morbidity rate is higher than those of the developed countries. Severe trauma rescue and treatment is not only a purely medical problem, but also a social problem related to public health system. The community and the government need to pay more attention, to face, and to find solutions to these issues. Our study suggests that the efficient integration network and cooperation among different teams, between the prehospital teams and hospital physicians under the SRP should be an efficient and low-cost way for China to treat this problem.

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Received: 08-01-2015 **Edited by:** Yi Cui

How to cite this article: Yin XF, Wang TB, Zhang PX, Kou YH, Zhang DY, Yu K, Lyu DC, Liu MZ, Zhou DS, Zhang P, Jing JH, Ge WW, Cao L, Wang GS, Deng SJ, Liu WH, Zhang M, Xu YA, Zhang K, Li B, Wang W, Gao ZL, Yi CL, Jiang BG. Evaluation of the Effects of Standard Rescue Procedure on Severe Trauma Treatment in China. *Chin Med J* 2015;128:1301-5.

Source of Support: This research project was funded by the Specific Research Project of Ministry of Health, China (No. 201002014), The 13th Five Year Research Plan of Ministry of Education, China (No. JKWZ-14-4). **Conflict of Interest:** None declared.