



Review Article

Regional whole-course trauma care – Experiences from a county-level hospital

Zi-Long Li*, Ping Jin, Hai-Hong Yuan, Jie-Feng Xu, Yong-Jie Chen, Zheng-Quan Wang, Zhe Li, Ya Fang, Xia-Di Yu

Department of Emergency, Yuyao People's Hospital Affiliated to Medical College of Ningbo University, Yuyao, Zhejiang Province, 315400, China

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ABSTRACT

Fifty percent of the deaths caused by severe trauma occur within 1 h after injury. With the concepts of “golden 1 h” and “platinum 10 min”, the professionals in the field of emergency trauma treatment have agreed on the necessity of establishing a rapid and efficient trauma rescue system. However, due to the size of the hospital, the population in the neighborhood, the local economic conditions and geographical features, how to establish an optimal trauma rescue system remains an issue. In this paper, we introduced our experiences in a county-level hospital located in middle-and high-income areas.

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Introduction

Studies have shown that 50% of trauma-induced deaths occur within 1 h after an accident, indicating that trauma rescue is significantly time-dependent.¹ How to make an objective and accurate assessment of trauma in the shortest time and carry out highly efficient and effective treatment has become the permanent topic in the field of traumatology. Recently, it is believed that strengthening the construction and operation of a trauma rescue system can effectively avoid various non-ideal diagnosis and treatment regimens in the early treatment of trauma and reduce the occurrence of preventable deaths within 1 h after trauma.² However, due to the unbalanced distribution of urban medical resources at all levels, the non-professional practice of trauma rescue team, as well as the particularity of incident sites and emergency respond,^{3–5} the definition of “suitable area for the trauma rescue management system” attracts much attention. Based on the characteristics of urban medical units at all levels and the demand for trauma treatment, we try to compare the difference on a regional traumatic emergency system between provincial comprehensive hospital and county-level general hospital in Table 1.

Yuyao is a county-level city in Zhejiang Province, China. Our hospital is the largest general hospital in the region, with more than

1, 200 beds, and undertakes the medical service of 1.2 million people in the city. There are 61 beds and 23 traumatic surgeons in the emergency department. In recent years, our hospital has established a whole-course trauma rescue system in the emergency department, including homogenization of the concept and technique of regional trauma rescue, standardized education and training focused at trauma care, digital management of “County-District-Township” 3-level network on regional trauma emergency, seamless connection between pre-hospital and in-hospital procedures, one-stop whole-course management mode of trauma rescue.⁶ After running four years with this program, the overall number of treated trauma patients and outcome of trauma care in the region have showed a good tendency (Table 2). The detailed introduction is as follows.

Trauma care capacity of the community-level hospital in this region

Generally speaking, in the administrative area of a county, the county central hospital (People's Hospital) has the highest capability of emergency medical service, while other hospitals, especially the district- and township-level hospitals or clinics, their capable of emergency treatment are limited. In the past four years, we have constructed the emergency medical platform affiliated to Yuyao People's Hospital, and continually improve the hardware and software of other hospitals or clinics in the region, which has remarkably enhanced their capabilities of emergency treatment.

* Corresponding author.

E-mail address: lizilong55@vip.sina.com (Z.-L. Li).

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Table 1

The features in regional traumatic emergency between different hospital.

	Provincial comprehensive hospital	County-level general hospital
Clinical level	Higher	Lower
Academic research	Strong	Weak
Regional influence	Weak. Trauma rescue mode in this area cannot be duplicated	Strong. It easy to connect with countryside clinics.
Trauma rescue network	Weak. Hard to cooperate with 1-2-0 emergency number and construct a regional 3-level trauma rescue network	Strong. The regional 3-level trauma rescue network achieves seamless connection between pre-hospital and in-hospital treatment
Emergency treatment	Far from the site	Near to the site
Patient admission	More transferred patients	More first visiting patients

Hardware construction

Until the end of 2016, each primary hospital has been equipped with a standardized rescue unit.

- (1) Area of emergency room: (23 ± 11) m²/bed.
- (2) Equipments in emergency room: ① rescue and monitoring equipments: electrocardiogram monitor, cardiopulmonary resuscitation machine (CPR), defibrillator; ② airway and respiratory support devices: endotracheal intubation equipment, cheek-distender, respiratory bladder, package of thoracic close drainage, package of thoracic puncture, oxygen bag, aspirator; ③ hemostatic and circulation support device: drainage needle, deep venous puncture package*, infusion pump*, debridement package, rib fixation tape, catheterization package ④ environmental insulation device: incubator*, heater*; ⑤ others: standard rescue bed, fast blood glucose meter, emergency lights, ECG, etc.
- (3) Medicine in emergency room: sedative and analgesic drugs, vasoactive drugs, resuscitatory drugs, hemostatic agents, etc. The detailed information of drugs is as follows (Table 3).

Software construction

The training of medical personnel is enhanced and the doctors should obtain the relevant certificate of qualification to fulfill their duty.

- (1) Employment training of emergency physicians: The job training for emergency physicians in community-level hospitals in the region is held once a year. After the training, if qualified, they will be granted a certificate of qualification valid for 3 years. At present, in our region, the percentage of emergency physicians with a certificate of qualification is required no less than 75%, actually, the percentage reaches to 79.6%.
- (2) Employment training of traumatic specialists: The professional training for trauma specialists among the regional hospitals or clinics is held once a year. After the training, if qualified, they will be granted a certificate of qualification valid for 3 years. At present, in our region, the percentage of traumatic specialist with a certificate of qualification is required at least 75%.

Table 2

The overall number of traumatic patients handled during the year 2014–2017.

Type of trauma care	2014	2015	2016	2017
Emergency	378,889	419,955	409,652	439,195
Trauma patient	6129	6385	5404	6808
Severe trauma (ISS > 16)	374	471	621	609
Surgical operation	2045	1636	1831	2346

- (3) The specialized training for trauma surgeon in primary or secondary level hospitals: Under the guidance of the Commission of Trauma Physicians of the Chinese Medical Association, based on the characteristics and needs of trauma treatment in secondary or primary hospitals, even local clinics, the program of China Trauma Care Training (Basic Version) (CTCT-b) has been held. The CTCT-b training was firstly held in August 2017, with the attendance of 62 participants. Results of the questionnaires on the training outcome were analyzed as follows: ① Training needs: the training program on trauma treatment is necessary, especially in primary hospitals; ② Theoretical teaching: The trainees were more interested in initial trauma assessment and treatment, on-site treatment, early treatment of shock, trauma related trap identification, etc. ③ Technical training: it is recommended to increase the related contents such as venous access, chest intubation, etc. ④ Trainbhf cing time: the optimal time is two years after the standardized training of residents. All medical personnel from the secondary or primary hospitals participating in the training are attentive and enthusiastic and the outcome is satisfactory.

Establishing a 3-level trauma rescue network system

At the beginning, totally 26 primary hospitals or clinics in our region are involved. We have established a regional 3-level trauma rescue network system, including branches in township-level hospitals or clinics (level III) – district hospitals and other secondary or primary hospitals (level II) – county central hospital (the trauma center of Yuyao People's Hospital, level I) (Figs. 1 and 2).

Table 3

The detailed information of drugs in emergency room.

No.	Category	Name of drugs	Specification	Quantity
1	Sedative	Midazolam/Liyuexi ^a	5 mg:1 ml	5
2	Sedative	Propofol ^a	50 g:50 ml	2
3	Sedative	Diazepam	10 mg:2 ml	5
4	Analgesic	Tramadol ^a	0.1 g:2 ml	5
5	Vasoactive	Norepinephrine	2 mg:1 ml	10
6	Vasoactive	Deacetylated lanoside	0.4 mg:2 ml	5
7	Vasoactive	Epinephrine	1 mg:1 ml	10
8	Vasoactive	Atropine	0.5 mg:1 ml	10
9	Vasoactive	Alamin	0.1 mg:1 ml	5
10	Crystal	Compound sodium chloride	500 ml	20
11	Crystal	Saline	500 ml	20
12	Colloidal	Wanwen ^a	500 ml	3
13	Colloidal	10% calcium gluconate	1 g:10 ml	5
14	Anti-fibrinolytic	Tranexamic acid ^a	0.5 g:5 ml	10
15	Hormonal	Dexamethasone	5 mg	5
16	Diuretic	Furosemide/Suniao	20 mg:2 ml	10
17	Dehydrating	20% mannitol	250 ml	3

^a Equipped for a trauma center at secondary hospital and above.

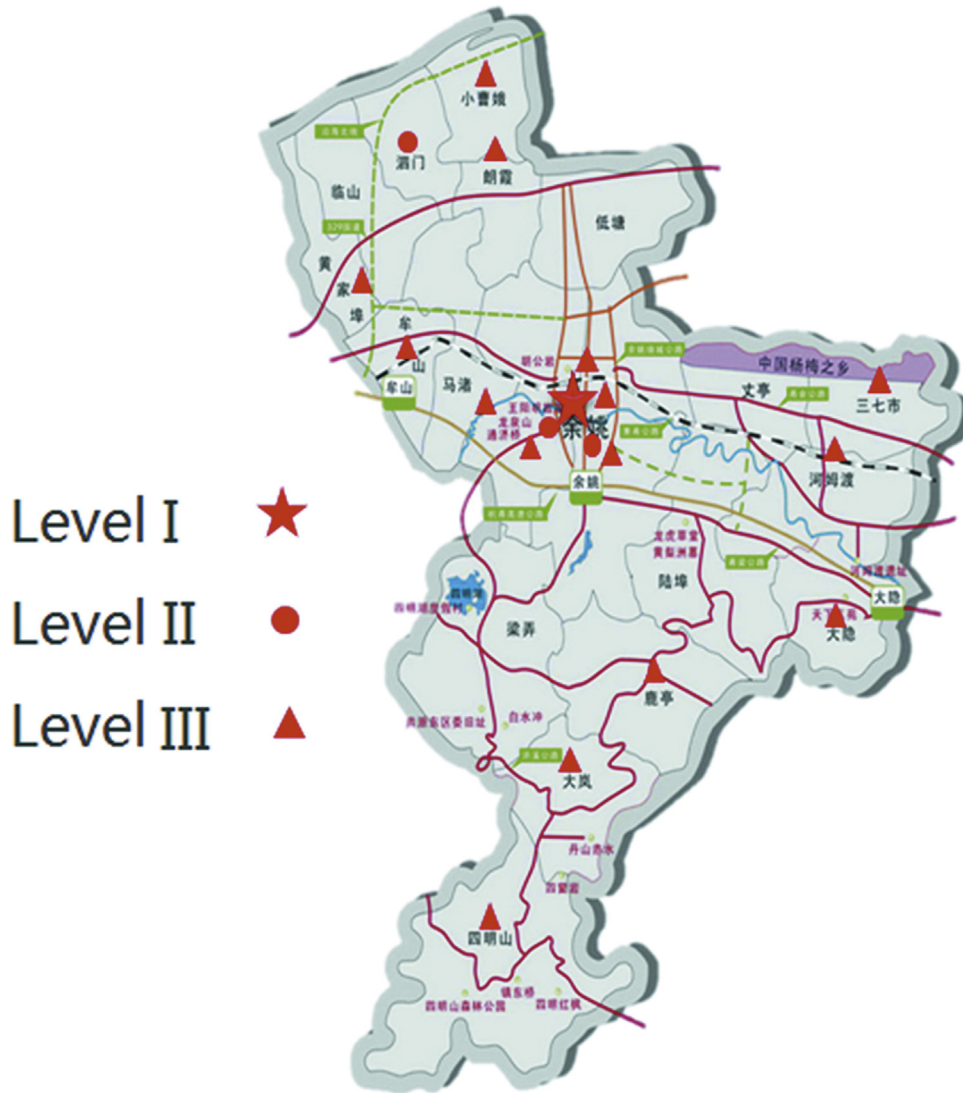


Fig. 1. Distribution map of network members.

According to the network grading, we set up the patient scope, emergency treatment requirements and rapid transfer procedures for trauma care branches at each level, and ensure that during the trauma treatment period, the trauma center of Yuyao People's Hospital (level I) can provide remote control and effective guidance on trauma care and rational distribution of medical resources to township-level primary hospitals or clinics (level III) and secondary or primary hospitals (level II). At present, the 3-level trauma care network system has just been initiated, which basically realizes the real-time healthy information exchange among all outlets.

Emergency medical service system with seamless connection between 1-2-0 emergency call, pre-hospital first aid and in-hospital emergency treatment⁷⁻⁹

With the application of modern 4G wireless network technology, the medical information from pre-hospital patients can be transferred to the emergency room in the hospital in real time through the audio-video system in 1-2-0 ambulances. By this means, it can receive the remote guidance of the senior physicians

in the emergency room in time, which not only ensures the standard on-site medical treatment and application of advanced first aid principles in our level I hospital, but also promote the preparation for the transferred trauma patients, and ultimately achieve continuous treatment without interruption. From 2014 to 2017, the treatment rate of trauma patients in the "golden 1 h" increased from 95.6% to 98.3% in our hospital, indicating that the new practice significantly improved the clinical outcome of trauma patients.

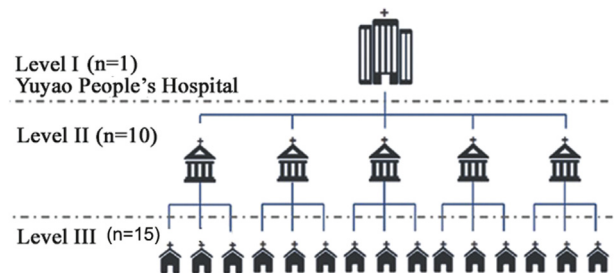


Fig. 2. Classification chart of trauma rescue network.

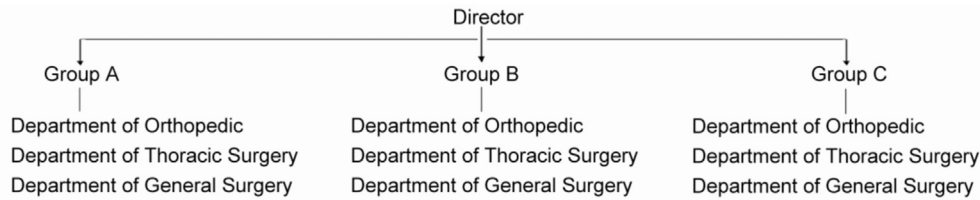


Fig. 3. Organization chart of medical team in trauma center.

Trauma care mode and team in Yuyao People's Hospital

In-hospital treatment mode

A one-stop whole-course trauma care mode was set up⁸ (Figs. 3 and 4). During the operation of one-stop whole-course trauma care mode, there are 3 trauma rescue groups, each group is solely responsible for the first-visiting patient from firstly diagnosis, hospitalization and operation. In addition, the first-visited clinician is responsible for the whole course of patients. Even after the patient is transferred to the ICU or special ward, the first-visited clinician should cooperate with the specialist in the diagnosis and treatment until the patient is discharged.

A complete in-hospital trauma care chain

A complete in-hospital trauma care chain is established in Yuyao People's Hospital, which consists of emergency room (surgery) – trauma resuscitation room—hybrid operating room—EICU (emergency intensive care unit)—TICU (traumatic intensive care unit)—wards for trauma patients.

Integrated management of wards and emergency rooms

The physicians in trauma center should be in charge of both the ward and emergency room, thereby it can avoid the unnecessary consultation and shorten the time patient waiting for emergency care.

Initial evaluation and re-evaluation

We develop the initial evaluation and re-evaluation process of trauma, which suits the needs of our hospital and standardizes the implementation of damage control recovery (DCR).¹⁰

Construction of emergency surgery subspecialties

Basically, traumatic surgeon should be one of the general practitioner, however some other specialties also need to be trained, such as orthopedics, general surgery, and thoracic surgery,

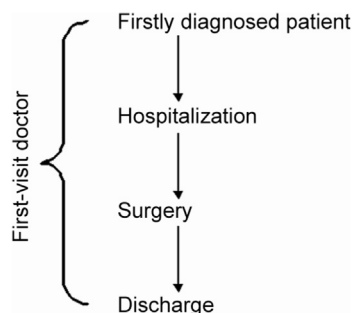


Fig. 4. The whole-course management mode for first-visit doctors.

even neurosurgery. Generally, five years' experience in trauma center is minimum.

Organizing a team of trauma care nurses

Trauma care nurses have been trained to ensure that the specialized nurses participate in all processes including pre-hospital transport – trauma resuscitation -TICU monitoring and treatment.

Early warning system for severe trauma – the tracing system for trauma patients

A follow-up system software for trauma patients is independently developed, which integrates Improved Early Warning Score (MEWS), Trauma Severity Score (ISS), and Glasgow Coma Scale (GCS), and serves as an early warning system for patients with severe multiple trauma. The system has different grades of alarming, e.g., if MEWS> 6, ISS> 16, GCS <8, automatic alarm will be triggered to remind medical staff to make timely response and initiate the standardized procedure including the doctor-patient communication, in order to minimize the risk of medical accidents and disputes (Fig. 5).^{11,12}

Establishing various platforms for serious trauma treatment

- (1) To establish a core trauma care team mainly including emergency surgeons
- (2) To establish a support team of trauma care mainly including the senior surgeons from different departments in our hospital.
- (3) To establish a hybrid operating room in the emergency room, which greatly improves the timeliness of serious trauma treatment.
- (4) To establish a TICU in the area for trauma patients, where the severe trauma patients and postoperative care patients from EICU and emergency room are admitted.

Establishing a trauma data platform

Using a variety of digital software, we have established a trauma data platform that comprises pre-hospital first aid, in-hospital diagnosis and treatment, and quality control of emergency treatment. There are 12 items in this data platform, including basic information, hospitalization, vital signs, green channels, rescue methods, special treatment, time of entry and exit in emergency room, diagnostic information, auxiliary examination, imaging examination, MEWS and ISS scoring system, single disease management in emergency, and aftermaths from emergency room.

Thanks to the trauma data platform, the following goals have been achieved: (1) The pre-hospital care information of trauma patients is accurately transmitted to the emergency room in real time, avoiding the drawbacks of asymmetric information transfer before and after hospitalization in the traditional rescue mode, and

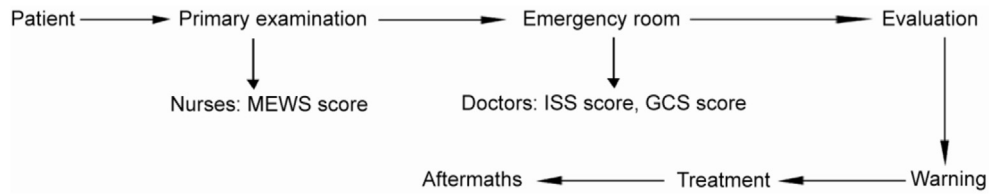


Fig. 5. The whole process of the tracing system for trauma patients.

achieving information exchange of pre-hospital and in-hospital treatment. (2) Real-time recording and storage of all data on quality control in emergency room overcomes the disadvantages of traditional paperwork such as messiness, omission and data loss. The dynamic observation, long-term preservation and easy access to the data are guaranteed. (3) The comprehensive data record of trauma treatment not only includes the general data such as the number of rescued patients, the success rate of trauma rescue, the mortality and cause of death, the number and proportion of patients in different specialties, disease type and its proportion, grading of trauma severity and the proportion of each grade, but also contains some quality control indicators such as retention time in emergency room, preoperative preparation time, preparation time before thrombolysis, which will provide important references for the hospital in arranging medical resources and improving emergency medical environment. (4) The capability of medical staff in emergency treatment for common critical illness and the ability to carry out common operation techniques are investigated to reveal the existing problems and improve the training program, thereby continuously enhancing the professional competence of medical staff.

The self-aid and buddy-aid training for citizens to build a integrated social trauma rescue chain

A complete chain of trauma care usually includes the self-aid and buddy-aid of citizens, 1-2-0 pre-hospital first aid, emergency treatment in hospital, surgical treatment, ICU stay and rehabilitation in ward. In recent years, we have held many training programs for the public in order to enhance the self-aid and buddy-aid abilities of citizens.¹²

- (1) In recent years, we have held 126 sessions of self-aid and buddy-aid training for the public in the region, with the attendance of 7419 trainees
- (2) A resuscitation alliance is established. For the public service personnel in the region, such as the police, volunteers, and white-collar workers in the community, a small-class specialized training is given and the trainees are enrolled in the resuscitation alliance so as to organize a volunteer team for trauma self-aid and buddy-aid in the region. There are currently 541 volunteers.
- (3) We have independently developed a “one-key self-aid” app, and established a public platform for self-aid and buddy-aid, to achieve an emergency respond system of “one key for help, five-party response”. The five parties are listed as follows.

The first party is social volunteers. When a person clicks the button for help in the “one-key self-aid” app, the personal information will be transmitted to the nearest qualified volunteer who will give timely assistance before the ambulance arrives.

The second party is the family member (emergency contact). Once “one-key self-aid” app is activated, the message will be texted to the family members.

The third party is the family doctor. “One-key self-aid” app also informs family doctors by short message service.

The fourth party is the 1-2-0 platform. The information will be sent to the 1-2-0 platform at the same time to help the accurate positioning of the patient.

The fifth party is the front end of the hospital. The information will be sent to the front end of the hospital at the same time, so the medical staff can have access to the medical history of the patient from the database and make full preparation for the patient’s arrival in advance.

Quality control parameters of trauma care and achievements in 2015–2016

In order to effectively implement the standard process of trauma treatment, improve the efficiency and quality of traumatic surgeon service, and improve the clinical outcome of trauma patients, we set some quality control parameters and requirements by digital quality control system.

- (1) Assessment of seamless connection between pre-hospital and in-hospital: The communication and information exchanges about the transporting trauma patient should be carried on between the nurse-in-charge in emergency room and the doctor in 1-2-0 ambulance. The seamless connection rate is used as the assessment parameter. That is, the number of admitted trauma patients/the number of all 1-2-0 ambulance transported patients \times 100%. The pre-hospital and in-hospital seamless connection rate is required to reach 100%.
- (2) The completion rate of trauma severity scoring: The trauma patients are required to be evaluated using MEWS, ISS, GCS score system in 5, 30, 60 min after admission respectively. The completion rate should reach 100%.
- (3) The completion rate of primary evaluation and treatment: The doctors are required to finish the ABCDE assessment of trauma patients within 10 min.
- (4) The completion rate of secondary evaluation: The doctors are required to finish all imaging examinations of trauma patients within 40 min.
- (5) Definitive treatment rate within “gold 1 h”: It is calculated by the time needed to complete the definitive treatment for trauma patients, including consultation, surgery, interventional treatment and hospitalization. The 1-h definitive treatment rate is required to reach 100%.
- (6) Mortality: The number and proportions of death cases in all trauma patients who have been admitted in emergency room.

From 2015 to 2016, there were 11,023 trauma patients (average ISS 7.38) admitted to the emergency room, Based on the statistical analysis of the data, all the above-mentioned indicators are good, with a tendency of steady improvement (Table 4). In particular, the proportion of deaths in trauma patients was only 1.84% and 1.49% respectively during the two years, which is significantly lower than 10% reported in literature.¹³ These results suggest that our trauma care mode has greatly improve the effectiveness of trauma treatment.

Table 4

The completion rate of trauma severity scoring and time-related treatment rate in 2015–2016.

	2015 (n = 5691)	2016 (n = 5332)	χ^2	p
Mortality	103/1.84%	79/1.49%	1.827	0.177
Seamless connection rate	1553/95.4%	1570/97.9%	16.233	0.000#
Primary evaluation rate	5549/97.5%	5233/98.2%	5.247	0.023#
Re-evaluation rate	5377/94.5%	5065/95.0%	1.434	0.231
Definitive treatment rate	5428/95.4%	5121/96.1%	2.950	0.086
MEWS scoring rate	5685/99.8%	5329/99.9%	0.816	0.366
GCS scoring rate	5582/98.1%	5305/99.4%	43.696	0.000#
ISS scoring rate	5509/96.8%	5211/97.7%	8.538	0.003#

Note: Compared with the data in 2015, #p < 0.05 is considered statistically significant.

In conclusion, after the four-year exploration and construction of a trauma management system, the trauma center in our hospital has basically realized the whole-course management of trauma patients in the region and achieved satisfactory results. In the next year, we will further improve the trauma management system, such as establishing a whole-course quality management system and a complete trauma rehabilitation process.

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