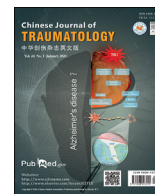




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## Original Article

## Advantage of surgical intensive care unit (SICU) predominant by cardiothoracic surgeons in multiple trauma management in a primary hospital

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## ABSTRACT

**Purpose:** It is a challenge for the primary hospitals to manage multiple trauma patients. In this article, we explored the advantage of establishing a surgical intensive care unit (SICU) predominant by cardiothoracic surgeons in the early management of multiple trauma.

**Methods:** This was a retrospective study and patients with multiple trauma in our hospital were collected and divided into two groups, based on time period and treat modes: group A (retrospective observation group) where patients were treated with the traditional treatment mode from January 2017 to December 2017 and group B (study group) where patients were treated in the SICU predominant by cardiothoracic surgeons from January 2018 to December 2018. Clinical data including demographics, injury severity score (ISS), causes of injury, time intervals from reception to entering SICU or operating room and mortality three days after injuries were collected. Data were analyzed by SPSS 20.0 software. Categorical variables were presented as number and/or frequency and continuous variables as mean  $\pm$  SD.

**Results:** Altogether 406 patients were included in this study, including 217 patients in group A and 189 patients in group B. General data between the two groups revealed no significant difference: mean age (years) ( $35.51 \pm 12.97$  vs.  $33.62 \pm 13.61$ ,  $p = 0.631$ ), gender distribution (mean/female, 130/87 vs. 116/73,  $p = 0.589$ ) and ISS ( $15.92 \pm 7.95$  vs.  $16.16 \pm 6.89$ ,  $p = 0.698$ ). Fall from height were the dominant mechanism of injury, with 135 cases in group A (71.4%) and 121 cases in group B (55.8%), followed by traffic accidents. Injury mechanism showed no significant differences between two groups ( $p = 1.256$ ). Introduction of the SICU significantly improved the care of trauma patients, regarding speed and mortality. Time intervals between reception and entering SICU or operating room was ( $108.23 \pm 6.72$ ) min and ( $45.67 \pm 7.96$ ) min in group A and B, respectively ( $p = 0.001$ ). Mortality three days after injuries was 13.89% and 5.53% in group A and B, respectively ( $p = 0.005$ ).

**Conclusion:** Establishing a SICU predominant by cardiothoracic surgeons can reduce the early mortality rates in multiple trauma patients.

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## Introduction

Multiple trauma remains one of the leading cause of death in the population younger than 44 years old worldwide.<sup>1,2</sup> Although the mortality of injury involved in multiple trauma systems have significantly decreased, lots of primary hospitals still have difficulty to manage multiple trauma patients.<sup>1</sup> As multiple trauma management requires coordination from several specialists, it is

imperative for us to explore a treatment model which is easy to put forward in hospitals that plan to or just start to treat multiple trauma patients. From January 2018, we established a surgical intensive care unit (SICU) predominant by cardiothoracic surgeons (SICU model) to rescue multiple trauma patients. Through analyzing the new rescue model and the traditional rescue model, we found some advantages of the new rescue model and presented those in the article in order to give some suggestions to primary hospitals that are inexperienced in handling with multiple trauma patients without enough critical care physicians.

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## Methods

Clinical materials of patients with multiple trauma from January 2017 to December 2018 were analyzed. Patients were divided into two groups according to the rescue model they received. Group A: patients treated with the traditional model from January 2017 to December 2017; group B: patients treated with SICU model from January 2018 to December 2018. Patients (1) died before transferring to hospital from the accident scene, (2) gave up on therapy or were transferred to another hospital within three days were excluded. Injury severity score (ISS), causes of injury, time intervals between reception and entering SICU or operating room and mortality three days after injuries were compared. Ethical approval for the study was obtained from the ethics committee of the hospital.

### Treatment

Patients were treated by either traditional rescue model (group A) or the SICU model (group B). Different from the traditional model, patients in group B were treated in SICU where the cardiothoracic surgeons were responsible for the management of the multiple trauma patients, evaluation of patient's condition, organization of multidisciplinary consultation, recording and making treatment plans from accident scene to transferring out of SICU after intensive care. Also, several actions were taken in group B compared with group A: (1) shortening time intervals between injury and treatment, (2) utilization of limited fluid resuscitation theory, (3) utilization of damage control theory.

### Assessment of the therapeutic effect in each group

Time intervals between reception and entering SICU or operating room, mortality three days after injuries in each group were compared between two groups.

### Statistical methods

Data were analyzed by SPSS 20.0 software. Categorical variables were presented as number and/or frequency and continuous variables as mean  $\pm$  SD. Analysis of measurement data was tested by *t*-test and enumeration data was tested by  $\chi^2$  test. Differences were statistically significant when *p* value was less than 0.05.

## Results

### General information

From January 2017 to December 2017, 217 patients with multiple trauma treated with the traditional rescue mode were served as group A. From January 2018 to December 2018, 189 multiple trauma patients treated in the SICU predominant by cardiothoracic surgeons were served as group B. For group A, there were 130 male and 87 female, patients' age ranged from 18 to 89 years, ISS ranged from 9 to 75 points, causes of injury include fall from height in 135 patients, traffic accident in 45, crush injury in 25 and fight injury in 12. For group B, there were 116 male and 73 female, patients' age ranged from 19 to 85 years, ISS is 10–53 points, causes of injury include fall from height in 121 patients, traffic accident in 37, crush injury in 18 and fight injury in 13. There was no significant difference of the general situations between the two groups (*p* > 0.05) (Table 1).

**Table 1**

Comparison of the general situations between patients from the two groups.

Variables	Group A (n = 189)	Group B (n = 217)	<i>p</i> value
Age (year)	33.62 $\pm$ 13.61	35.51 $\pm$ 12.97	0.631
Gender			0.589
Male	116 (61.4)	130 (59.9)	
Female	73 (38.6)	87 (40.1)	
Cause of injury			1.256
Fall from height	135 (71.4)	121 (55.8)	
Traffic accident	45 (23.8)	37 (17.1)	
Crush injury	25 (13.2)	18 (8.3)	
Fight injury	12 (6.3)	13 (6.0)	
ISS (points)	15.92 $\pm$ 7.95	16.16 $\pm$ 6.89	0.698
Time interval between reception and entering SICU or operating room (min)	108.23 $\pm$ 6.72	45.67 $\pm$ 7.96	0.001
Mortality three days after injury (%)	13.76	5.53	0.005

Data present as *n* (%) or mean  $\pm$  SD.

ISS: injury severity score.

### Therapeutic effect in each group

The therapeutic effect was significantly improved after the induction of SICU, both in time interval (min) between reception and entering SICU or operating room (108.23  $\pm$  6.72 in group A vs. 45.67  $\pm$  7.96 in group B, *p* = 0.001) and mortality three days after injury (13.76% in group A vs. 5.53% in group B, *p* = 0.005). Detailed data are shown in Table 1.

## Discussion

Multiple trauma patients are quite common. Although tertiary hospitals are familiar with how to decrease mortality following injury, primary hospitals still have difficulty to handle the tough situation. The three top reasons demonstrated to cause death in multiple trauma patients are<sup>2–5</sup>: (1) missing the chance to treat patients within the so called “golden hour of shock”, (2) hemorrhagic shock, (3) multiple organ dysfunction syndrome (MODS). So, how to reasonably handle these three challenges are still the focuses of the clinical research. In this study, we demonstrated that SICU model and shortening time intervals between injury and treatment, emphasizing reasonable utilization of limited fluid resuscitation and damage control theory can decreased the early mortality in multiple trauma patients.

### Advantage of SICU model in the management of multiple trauma patients

Until now, there is not a uniformly accepted rescue model for the management of multiple trauma patients all over the world.<sup>6–8</sup> In order to avoid shirking responsibility of each other among doctors from different departments when managing multiple trauma patients, the concept to establish a special department with critical care physician to manage multiple trauma patients is now widely accepted. But for primary hospitals where there are not enough critical care physicians, they have to find a rescue model fits themselves. Based on our hospital situation and some literatures, we established SICU model in the management of multiple trauma patients. The reason why we select cardiothoracic surgeons is that they are more familiar with patient's blood circulation than other specialized physicians and they also can treat both heart injury and lung injury at the same time without seeking advice from other specialized physicians. In this study, we demonstrated that mortality of multiple trauma patients treated by SICU model is much

less than ordinary rescue model, which implies that establishing SICU model in the management of multiple trauma patients in primary hospitals may be a good choice.

#### *Time management is vital for successful trauma care*

In the 1970's, Cowley put forward the so-called "golden hour of shock" for the first time. Since then, countless studies have emphasized the importance to minimize the time elapsed between the traumatic impact and referral of the patient to the operation theatre. Since January 1st 2018, we trained our first-aiders on pre-hospital care monthly to make sure they can give basic life support to patients at accident scene within 10 min and update patient's condition to cardiothoracic surgeon from SICU immediately. Through doing these, we decreased the time elapsed between the traumatic impact and referral of the patient to the operation or SICU from previous ( $108.23 \pm 6.72$ ) min to ( $45.67 \pm 7.96$ ) min, which is essential for our successful trauma care.

#### *Limited fluid resuscitation*

Hemorrhagic shock is one of the main causes of death in patients with multiple trauma. Goal of fluid resuscitation has changed from administration of a specific volume of fluid to correct shock to minimize the risk of dislodging vascular clots.<sup>9,10</sup> Through limited fluid resuscitation, patients with active, non-compressible hemorrhage is resuscitated to a mean arterial pressure (MAP) of no greater than 60 mmHg, and aggressive fluid resuscitation is only initiated when bleeding is controlled. In this study, patients with active, non-compressible hemorrhage in group A were first given isotonic crystalloids to achieve the goal of systolic pressure >90 mmHg and diastolic pressure >60 mmHg before receiving operation; while in group B, patients with active, non-compressible hemorrhage received operation once the MAP is around 60 mmHg by limited fluid resuscitation.<sup>11</sup> Mortality in group B at three days after injury was 7.41%, less than that of 16.67% in group A, which demonstrated that limited fluid resuscitation for active, non-compressible hemorrhage patients was much better than traditional fluid resuscitation.

#### *Damage control theory*

Multiple trauma patients sustained uncontrolled bleeding should be treated following damage control theory.<sup>12</sup> Damage control theory which contains damage control surgery and damage control resuscitation emphasizes on temporary control of bleeding and further contamination instead of giving definitive surgery to patients or conducting resuscitation. At the same time, damage control theory requires to control hemorrhage, maintain circulating volume and correct the "lethal triad" of acidosis, coagulopathy and hypothermia until definitive intervention is appropriate.<sup>13</sup> In this study, 87 patients with uncontrolled bleeding in group A received definitive surgery and resuscitation at the same time, and the mortality three days after injury is 25.29%; whereas, 121 similar patients sustained uncontrolled bleeding in group B were treated with damage control theory, and their mortality three days after injury is 4.96%, which further demonstrated damage control theory is reasonable for multiple trauma patients sustained uncontrolled bleeding.

In this retrospective study, we demonstrated that SICU model can reduce the early mortality rates in multiple trauma patients. However, there are several modifications: (1) shortening time

intervals between injury and treatment, (2) utilization of limited fluid resuscitation theory, (3) utilization of damage control theory in SICU model compared with traditional model other than predominant by cardiothoracic surgeon, so we cannot conclude SICU predominant by cardiothoracic surgeon is better than SICU predominant by critical care physician. But our study to some extent provides some advantages of SICU model to those primary hospitals plan to or start to treat multiple trauma patients without enough critical care physicians. We believe in the near future, with further studies on multiple trauma rescues, better rescue models will be displayed.

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#### **Ethical statement**

This retrospective study was approved by ethics board of Zhengzhou First People's Hospital. All the data used in this study were anonymized before use.

#### **Declaration of competing interest**

Authors declared no potential conflicts of interest.

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