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The treatment of severe and multiple injuries in intensive care unit: report of 80 cases

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Abstract. – OBJECTIVE: To summarize our case load in managing severe and multiple injuries (SMI) in the Intensive Care Unit (ICU).

PATIENTS AND METHODS: The clinical data of 80 SMI patients treated in our ICU from January 2009 to June 2013 were analyzed.

RESULTS: Results of these 80 SMI patients, 60 (75%) were salvaged and 15 (18.75%) died. The causes of death included severe head injury (n=7), severe chest injury (n=3), destruction of injured abdominal organs (n=2), and multiple organ dysfunction syndrome (n=3). Five patients (7.50%) gave up treatment and were discharged upon their own requests. Early application of continuous renal replacement therapy (CRRT) and enteral nutrition (EN) improved outcomes.

CONCLUSIONS: The key interventions during the ICU treatment of SMI include: adequate analgesia and appropriate sedation; timely management of hypoxemia; reasonable fluid resuscitation and CRRT.

Key Words:
Severe and multiple injuries, Intensive Care Unit.

Introduction

Patients with severe and multiple injuries (SMI) are critically ill and at high risks of death and complications, and, therefore must be treated. Intensive care unit (ICU) monitoring and management plays a key role in this process. A total of 80 SMI patients had been treated in our department from January 2009 to June 2013. Here is a summary of our case load in monitoring and managing these patients.

Patients and Methods

Amongst the 80 SMI patients, 68 were men and 12 were women aged 13-80 years (mean: 47.5 years). The causes of SMIs included traffic accidents (n=38), industrial and mining accidents (n=13), fall from heights (n=15), knife or puncture wounds (n=4), blast injury (n=2), and others (n=7). The locations of these injuries were distributed in the head/brain (n=51), maxillofacial region (n=9), chest (n=54), abdominal region [n=52; including liver (n=9), spleen (n=13), pancreas (n=3), colon (n=2), kidney (n=11), adrenals (n=3), mesenterium (n=2), retroperitoneal haematoma (n=9), and bladder and ureter (n=1)], pelvis (n=16), and vertebrae [n=15; including cervical vertebrae (n=4), thoracic vertebrae (n=5), lumbar vertebrae (n=6)]. In addition, there were two patients had paraplegia and 28 had wound at their limbs. Also, 39 patients had two injuries, 20 had three injuries, and 21 had 4 or more injuries; 32 patients also suffered from shock.

The diagnostic criterias were as follows; severe and multiple injuries were defined as the severe trauma of two or more anatomic locations or organs due to the same causative factor of injury, with one injury being fatal or accompanied with shock. Nine injury locations were described according to the AIS 90, and injuries with an Injury Severity Score (ISS) score > 16 were identified as SMIs.

Analgesia and sedation were administered to all patients. The respiratory tract was kept open to maintain oxygen supply in 48 patients and invasive mechanical ventilation was applied. Advanced life support was provided in four patients who had undergone cardiopulmonary resuscitation (CPR). Thirty-five patients received emergency surgery, amongst whom the following procedures were performed: craniotomy (n=15), exploratory thoracotomy or closed thoracic drainage (n=10), exploratory laparotomy (n=12), internal or external fixation for fractures (n=8), and others (n=5). Enhanced monitoring was pro-

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vided to address any surgical problems encountered during ICU treatment. Active anti-shock therapy was applied in patients diagnosed with shock. Continuous renal replacement therapy (CRRT); (n = 18) and early enteral nutrition (EN); (n = 40) were applied to prevent secondary infections and for organ supports.

Statistical Analysis

For the statistical analysis, data were processed and analyzed using SPSS software (SPSS Inc., Chicago, IL, USA). Rates were compared by using the chi square test, and a $p < 0.05$ was considered statistically significant.

Results

Of the 80 SMI patients, 60 (75%) were saved and 15 (18.75%) died. The causes of death included severe head injury (n=7), severe chest injury (n=3), destruction of injured abdominal organs (n=2), and multiple organ dysfunction syndrome (n=3). Five patients (7.50%) gave up treatment and were discharged upon their own requests.

Continuous renal replacement therapy was applied in 18 patients during the ICU management. Amongst them, six suffered from acute kidney failure, of whom four were treated and two died. Severe water-electrolyte imbalance was noted in five cases, amongst whom three were treated and two died. Sepsis was found in three cases, of whom two were treated and one died. Four patients experienced acute respiratory distress syndrome (ARDS), of whom four were treated and none died.

Of the 80 patients, 40 received early EN supports within 24-48 hours after the surgery through medications, surgeries (e.g. jejunostomy), or interventions (e.g. endoscopic placement of nasal jejunal feeding tubes or PEG/PEJ). In contrast, 40 patients did not receive early EN support. As shown in Table I, the rate of enterogenic infections were lower and the salvage success rate was higher in the early EN group than in the non-EN group (both $p < 0.05$) (Table I).

Discussion

As fatal conditions, SMIs can affect multiple organs and systems and, thus, require coordinated multidisciplinary management. In the past two decades, we have witnessed the fundamental changes in the in-hospital rescue of SMIs. An integrated multidisciplinary mode that combines emergency resuscitation, emergency surgery, ICU resuscitation, and definite surgery after the condition becomes stable has become a new standardized approach. Emergency surgeries are important in addressing fatal injuries to save lives. Nevertheless, the well-trained staff and sophisticated monitoring equipment in ICU have their unique advantages in providing further life support to SMI patients. Based on managing our case load of 80 SMI patients, we suggest the following recommendations:

The use of adequate analgesia and appropriate sedation will earn a window of time for the recovery of organ functions. Analgesia and sedation are parts of the basic treatment for the ICU patients. They make the patients feel comfortable, protect and prevent organ dysfunction[1-3]. All patients were given fentanyl with midazolam or dexmedetomidine at admission for analgesia and sedation. The response of these ill patients to the analgesic/sedative drugs may differ. Pain perception can be affected by a variety of factors. Both the standardization and the individualization of the treatment strategies are important for achieving our goals[1,2,4].

The management of hypoxemia as well as the appropriate fluid resuscitation strategy (adequate first, then restricted) are key to saving lives. The

Table I. Enterogenic infections and prognosis in the early EN group and the non-EN group.

	Total cases	Survived cases (%)	Cases with enterogenic infections (%)
Early EN group	40	40 (100%)	3 (7.5%)
Non-EN group	40	20 (50%)	18 (45%)
χ^2 value		26.667	14.528
p value		0.001	0.001

SMIs are associated with a high incidence of acute hypoxemia, which can cause tissue hypoxia, accumulation of lactic acid in tissues, and massive release of inflammatory mediators, which further increases tissue damage and worsens the disease conditions. Endotracheal intubation and mechanical ventilation are effective in adjusting hypoxemia and hypercapnia and, therefore[5,6], have been adopted for the management of multiple injuries. According to Pelosi et al[7], endotracheal intubation and mechanical ventilation should be applied in patients with primary respiratory dysfunction caused by traumatic brain injury or high paraplegia and in patients with secondary respiratory depression due to chest injuries, in those with an ISS core of ≥ 35 and a GCS score of ≤ 8 and accompanied with shock. Based on the principles of "early on and early off (the respirator)" and "individualization[8-10]", different modes and parameters should be selected for each patient. Appropriate ventilation and adequate oxygenation should be ensured when minimizing circulation disorders. Severe injuries are often associated with shock, which is the most important cause of deaths. Except for patients with head/brain injuries, elderly patients, and hypertensive patients, limited fluid volume resuscitation should be applied before the bleeding is controlled[11]. Once the bleeding has been controlled, blood and fluid transfusion should be performed. Adequate and rapid fluid supplementation is required in patients with traumatic hemorrhagic shock. Rapid supplementation of more than 1500 ml fluid will decrease the incidence of multiple organ dysfunction, acute lung injury, and nosocomial infections[12]. However, the fluid volume should be restricted in later stages. Petrasovicova and Michard et al[13,14] found that patients with larger positive fluid balance tend to have poorer prognosis, in particular, they have a high occurrence of organ dysfunction and a higher mortality rate.

Research has shown that, in patients with multiple injuries, the early application of CRRT can remove pro-inflammatory mediators and restore the antigen-presenting function of mononuclear cells, thus playing a key role in regulating immunity and re-establishing the immune homeostasis. In these critically ill patients, only CRRT can block the inflammatory processes. Today, the applications of CRRT have been far beyond kidney diseases; in fact, it has been used for managing severe trauma, infections, systemic inflammatory response syndrome (SIRS), burns, acute pancreatitis, and chemical poisoning. The CRRT-based multi-organ supporting approaches have shed new light on the management of multiple injuries. According to our experiences with treating 18 patients using the continuous venovenous hemofiltration (CVVH) mode, CRRT should be administered as early as possible in patients who meet the following criteria[15]: (1) indicated for blood purification; (2) well controlled primary injuries; (3) stable vital signs; d) without active bleeding; and e) tolerable to CRRT[15]. At the early stage of multiple injuries, the risk of bleeding may hamper the application of CRRT. In fact, unstable circulation is not a definite contraindication to CRRT. In our series, two patients had severe traumatic brain injuries. They suffered from unstable circulation and anuria even after the use of high-dose norepinephrine and epinephrine during the surgeries. After the surgery, pituitrin was pumped at a rate of 2 U/hour to increase blood pressure; and one hour later, the circulation became stable. Continuous renal replacement therapy was then applied, to improve circulation within a short period.

During the earlier stages, low-molecular-weight heparin is used at a reduced dosage; or, no heparin during the anticoagulation, to lower the risk of bleeding. However, it is important to maintain the blood flow at a certain level and flush the catheter every four hours, to prevent blood coagulation *in vitro*. During the later stages, the dosage of low-molecular-weight heparin can be increased. In some cases, it can also be used at a dose higher than the conventional one.

Nutrition therapy serves as a cornerstone to manage patient outcomes. Early (within 24-48 hours after surgery) EN has been proven to be a key step in the nutrition therapy for critically ill patients[16-19]. Nutritional supplements before the depot protein and fat mobilization will slow down the inflammatory response, enhance immunity, reduce the risk of ICU infection, decrease bacterial translocation, and shorten the duration of the ICU stay and mechanical ventilation. In our current study, 40 patients who underwent early EN had less enterogenous infections and longer survival. Multiple injury patients often have gastrointestinal dysfunction. Therefore, rational use of early EN is a challenge during the rescue of SMI patients. In this regard, we recommend the following: (1) Early and adequate fluid resuscitation to minimize the use of vasoactive drugs and improve the blood supply of gastrointestinal tract; (2) In patients who have undergone abdominal surgery and require postoperative EN support, a jejunostomy tube can be placed during the surgery, or a jejunal feeding tube can be placed at the distal end of gastroenteric stoma; (3) In patients who have suffered from severe head/brain injuries, the risk of central gastroplegia can be high, and thus gastric retention can occur. In these patients, gastroscopic placement of nasointestinal tube should be performed once the vital signs become stable. (4) Forget the bowel sounds. Bowel sounds represent the contraction and peristalsis of the intestine. In fact, they are not relevant with the integrity, barrier function, and absorptive capacity of the intestinal mucosa. We restore, the intestine peristalsis was using nasally administered rhubarb, mosapride, and microorganism preparations in combination with enema treatment. (5) Predigested formulas can be used then followed by whole protein formulas. The warmth, concentration, and feeding speed of the formulas should be considered to avoid abdominal distention and diarrhea. However, even after implementing these measures, quite a few patients are still unfeasible for early EN support. Currently, the early start of EN (within 0-24h) is proposed for the management of multiple injuries.

Conclusions

Coordinated multidisciplinary approaches have been introduced to manage SMIs, with an attempt to provide effective treatment within a short time to save lives and reduce disabilities. Intensive care unit management is a key link in this process and plays an important role in increasing the success rate. Based on the management of 80 SMI patients, we propose the following recommendations: adequate analgesia and appropriate sedation; timely management of hypoxemia; reasonable fluid resuscitation and CRRT.

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Conflict of Interest

The Authors declare that there are no conflicts of interest.

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