



## Neurological Intensive Care for Acute Spinal Cord Injury Patients

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The spinal cord injury (SCI) patients suffer various medical conditions at early period after injury. Methylprednisolone could be administrated for neurologic recovery but the potential side effects could be carefully considered. Besides limb motor and sensory deficits, SCI could affect various respiratory muscles as diaphragm, chest wall, and abdomen which leads to respiratory failure and mechanical ventilation. Sympathetic nerve denervation could lead hypotension and bradycardia. Volume supplement and cardiovascular constrictor could be considered. Prevention and treatment of pressure sore are essential and active pain control should be started from the intensive care unit.

**Keywords:** Spinal cord injury; Neurology; Intensive care; Shock; Methylprednisolone

## INTRODUCTION

In the 21st century, remarkable advances in medicine have led to the development of treatments for many diseases. However, in the case of spinal cord injury (SCI), no clear solution has been found to restore neural damage even after pouring astronomical research costs into the development of new therapeutic drugs. However, it is encouraging that many empirical knowledge about acute critical care has accumulated. We will review the problems that may appear in patients immediately after injury of the spinal cord and summarize the latest knowledge for the treatment of patients in the neurological intensive care unit.

## CLINICAL MANIFESTATIONS

### 1. Motor and sensory deficit associated to injury level

Spinal cord injury levels due to vertebral fractures may differ from spinal cord injury levels in actual clinical symptoms. For

example, fracture and spinal cord compression at T5 level could induce neurologic symptom below T10. Therefore, accurate manifestation of neurologic disorders should be held. Depending on the level of nerve damage, the sensory and motor nerve damage ranges are determined. Furthermore, there are also other important points to consider due to injured level as respiratory function failure, reduced sympathetic nervous function, immunodeficiency and etc.

### 2. Respiratory dysfunction

Phrenic motor neurons are located at C3-S. Therefore, damage above the C5 may affect diaphragm function, resulting in hypercapnia, hypoxemia, and poor secretion clearance<sup>10, 17</sup>. Injuries above T11 destroy innervation to the intercostal muscles leading to reduced chest wall motion, and injuries above L1 may interfere the innervation to the abdominal muscle<sup>1</sup>. These neurological deficits can cause serious respiratory problems as dyspnea, apnea, and pneumonia.

### 3. Neurogenic shock

Injury above T6 may affect sympathetic nerve and induce hypotension and bradycardia due to vasodilatation<sup>14)</sup>. For cervical lesion injury, 20% of patients show neurogenic shock and almost all patients show bradycardia<sup>8)</sup>. If there is no evidence of severe blood loss after trauma, neurogenic shock should be considered.

## NEUROGENIC INTENSIVE CARE

### 1. Methylprednisolone

Three large randomized clinical trials named National Acute Spinal Cord Injury Studies (NASCIS) were performed. First trial published at 1984 concluded there is no significant difference between high dose methylprednisolone group (1,000-mg bolus and daily thereafter for ten days) and standard dose methylprednisolone group (100-mg bolus and daily thereafter for ten days)<sup>2)</sup>. However, second trial adapted different infusion amount and type of methylprednisolone for the treatment group (a bolus of 30 mg per kilogram of body weight, followed by infusion at 5.4 mg per kilogram per hour for 23 hours) compared with naloxone administrated and placebo groups. This study concluded methylprednisolone have positive effect for the neurology recovery at 6 months period after injury<sup>3)</sup>. The third NASCIS reported that patients receiving methylprednisolone within 3 hours of injury should be maintained on the treatment regimen for 24 hours and 48 hours when initiated 3 to 8 hours after injury. After this studies, high dose methylprednisolone has emerged as golden standard therapy for SCI. However, numerous comments against those have been poured out. Many scientist and physicians pointed out the statistical bias. Numerous retrospective and prospective studies refute the second and third NASCIS conclusion. They claimed there was no neurologic difference between high methylprednisolone group and placebo group, however, complications as gastrointestinal bleedings, wound infection, sudden death, pulmonary embolism seemed to be higher incidence for high dose methylprednisolone group<sup>6, 11, 15)</sup>. The two arguments are still conflicting and have been subject to contradictions that have been reversed according to the guidelines. Therefore, the authors recommends to use it according to the judgment of the clinician.

### 2. Hemodynamics

Maintenance of adequate blood supply to spinal cord is essential. Systemic hypotension should be avoided. Mean arterial pressure (MAP) between 85~90mmHg is recommended and systolic blood pressure under 90mmHg should be avoided

for the first 7days post injury. Oxygen saturation should be maintained over 90%<sup>9, 16)</sup>. To prevent hypotension, lower extremity compression stockings, abdominal binding, volume augmentation (hydration, salt tablets or fludrocortisone), peripheral vasoconstriction (midodrine, ephedrine or droxidopa) should be considered<sup>12)</sup>.

### 3. Respiration

Depending on the level and degree of SCI, spontaneous breathing may not be smooth due to paralysis of the diaphragm, chest wall, and abdomen muscle. Therefore, if the patient's respiration pattern is paradoxical or if the saturation is continuously lowered to 90% or less, intubation and mechanical ventilation should be considered. Even if the breathing seems not so bad at early period, the oral secretions cannot be spit out well, so the airway obstruction often occurs. Theophylline could be helpful for respiratory function improvement<sup>5)</sup>. There are studies that muscle spasticity could affect respiration function, and in this case, baclofen could be helpful<sup>4, 13)</sup>.

### 4. Pressure sores

With sensory loss and immobilization due to motor deficit, pressure sores develop rapidly. Sore starts with focal infection and if not controlled well, immunodeficiency and systemic infection could occur and life threatening condition could be caused. Prevention is the most important treatment. Frequent position change, using anti-sore mattress are helpful. Once a sore develops, daily dressing, surgical debridement, vacuum suction could be considered<sup>7)</sup>.

### 5. Pain control

Active control of pain is essential from the beginning of SCI treatment. If the pain is not controlled, the prognosis of the patient is adversely affected. Additionally to nociceptive pain, neuropathic pain as allodynia and hyperalgesia occur almost 40% of SCI patients<sup>1)</sup>. NSAIDs, anticonvulsants, antidepressants, and opioids should be considered.

## CONCLUSION

SCI patients suffer various medical conditions from the early period of injury. Meticulous clinical manifestations and appropriate intensive treatments are mandatory.

## CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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