



Early Versus Delayed Surgical Decompression of Spinal Cord after Traumatic Cervical Spinal Cord Injury: A Cost-Utility Analysis

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■ **OBJECTIVE:** This cost-utility analysis was undertaken to compare early (≤ 24 hours since trauma) versus delayed surgical decompression of spinal cord to determine which approach is more cost effective in the management of patients with acute traumatic cervical spinal cord injury (SCI).

■ **METHODS:** This study includes the patients enrolled into the Surgical Timing in Acute Spinal Cord Injury Study (STASCIS) and admitted at Toronto Western Hospital. Cases were grouped into patients with motor complete SCI and individuals with motor incomplete SCI. A cost-utility analysis was performed for each group of patients by the use of data for the first 6 months after SCI. The perspective of a public health care insurer was adopted. Costs were estimated in 2014 U.S. dollars. Utilities were estimated from the STASCIS.

■ **RESULTS:** The baseline analysis indicates early spinal decompression is more cost-effective approach compared with the delayed spinal decompression. When we considered the delayed spinal decompression as the baseline strategy, the incremental cost-effectiveness ratio analysis revealed a saving of US\$ 58,368,024.12 per quality-adjusted life years gained for patients with complete SCI and a saving of US\$ 536,217.33 per quality-adjusted life years gained in patients with incomplete SCI for the early spinal decompression. The probabilistic analysis

confirmed the early-decompression strategy as more cost effective than the delayed-decompression approach, even though there is no clearly dominant strategy.

■ **CONCLUSIONS:** The results of this economic analysis suggests that early decompression of spinal cord was more cost effective than delayed surgical decompression in the management of patients with motor complete and incomplete SCI, even though no strategy was clearly dominant.

INTRODUCTION

Traumatic spinal cord injury (SCI) is a potentially catastrophic event for individuals who may sustain motor, sensory, and autonomic deficits and for society because of the economic burden. The worldwide incidence rate of SCI varies from 6.2 to 174 per million inhabitants yearly, and the global prevalence ranges from 50 to 906 per million inhabitants.¹ Although traumatic SCI has a relatively modest incidence, its burden is substantial. In the United States, the total expenses of care for each individual during the first year with cervical SCI were estimated between 754,524 and 1,044,197 U.S. dollars (2013) for high (C1–C4) and low tetraplegic (C5–C8), respectively.² The total national changes related to hospitalizations to manage patients with SCI was approximately 1.69 billion U.S. dollars in 2009.³ In Canada, the total estimated direct hospital cost of SCI is 40.6 million (2001) U.S. dollars.⁴

Key words

- Cost-utility analysis
- Costs
- Economics
- Rehabilitation
- Spinal cord decompression
- Spinal cord injury
- Spine surgery
- Timing
- Trauma
- Utility

Abbreviations and Acronyms

AIS: American Spinal Injury Association Impairment Scale

ICER: Incremental cost-effectiveness ratio

OMHLTC: Ontario Ministry of Health and Long Term Care

QALY: Quality-adjusted life year

SCI: Spinal cord injury

STASCIS: Surgical Timing in Acute Spinal Cord Injury Study

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The estimated lifetime economic cost to care for an individual with SCI varies from 2,105,811 to 3,026,028 Canadian dollars (2011) for incomplete and complete tetraplegia, respectively.⁵

Despite all the progress in the prevention and management of patients with SCI, further improvements in their care seem to be tangible before any potential breakthrough from promising pre-clinical neuroprotective and regenerative strategies. On the basis of the emerging evidence from preclinical and clinical studies, the early surgical decompression of spinal cord after traumatic SCI could potentially decrease the length of stay in the intensive care unit and decrease the frequency of secondary complications.⁶ Also, the results of the Surgical Timing in Acute Spinal Cord Injury Study (STASCIS) indicate that surgical spinal cord decompression and reduction within the first 24 hours after trauma could reduce the degree of impairment after cervical SCI.⁷

Given this, we carried out this cost-utility analysis to compare early with delayed surgical decompression of spinal cord to determine which approach is more cost effective at a willingness-to-pay of US\$ 50,000 in the management of patients with acute traumatic cervical SCI in the context of a publicly funded health care system.

METHODS

The University Health Network Research Ethics Board approved the protocol of this study. This analysis adopts the perspective of the public payer, the Ontario Ministry of Health and Long Term Care (OMHLTC). An analytic decision model was built to compare 2 strategies: early versus delayed surgical decompression of spinal cord (Figure 1). After the decision node to select a particular treatment modality, there are 2 initial symmetric chance nodes for each therapeutic strategy that reflect the probability of having complications after each initial treatment. All underlying initial health states that could influence outcomes are included in each branch of the decision tree.⁸ Subsequent chance nodes

correspond to the possible consequences of each strategy within the initial 6 months after traumatic SCI.

Clinical Information

The probabilities and rates of clinical events for this model are based on the data from the STASCIS.⁷ The study population was divided into 2 different groups of patients according to the severity of cervical SCI as assessed by the American Spinal Injury Association Impairment Scale (AIS) as follows: 1) patients with motor and sensory complete SCI (AIS A) or motor complete but sensory incomplete SCI (AIS B); and 2) patients with motor incomplete SCI where the majority of the key muscles below the neurologic level have a muscle grade less than 3 (AIS C) or the majority of the key muscles below the neurologic level have a muscle grade greater than or equal to 3 (AIS D).⁹ The level of SCI was classified into high (C1–C4) and low tetraplegia (C5–C8).² All cases were followed for a period of 6 months after SCI.

Costing Information

Direct costs for the acute medical and rehabilitation care during the first 6 months after the injury were obtained from 3 sources. First, we retrieved the direct costs (i.e., hospital expenses) related to the hospitalization for each patient admitted to the acute SCI care unit at Toronto Western Hospital who were enrolled in the STASCIS. Second, the direct costs for hospitalization in a rehabilitation center during the first 6 months postinjury were obtained from Ontario Costing Case Initiative, which was established in 1992 as a joint initiative of the Ontario Hospital Association and the OMHLTC to develop a cost database.¹⁰ Third, all physician fees were obtained from the Ontario Health Insurance Plan schedule of benefits. The physician fees included surgeons' fees, anesthesiologists' fees, surgical assistants' fees, and physiatrists' fees. All the costs were adjusted to 2014 U.S. dollars based on the currency conversion and inflation rates from the Bank of

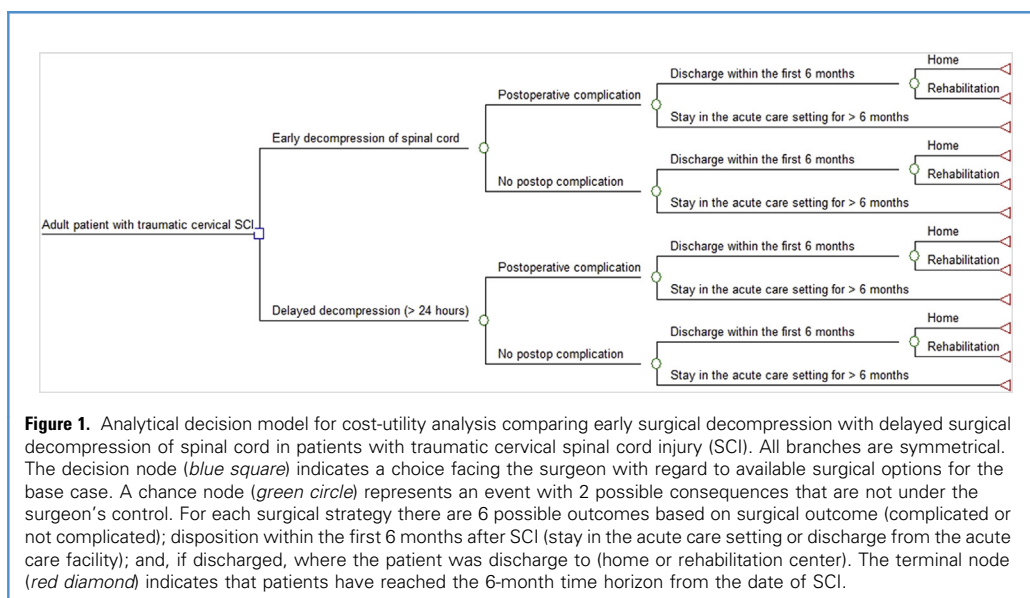


Figure 1. Analytical decision model for cost-utility analysis comparing early surgical decompression with delayed surgical decompression of spinal cord in patients with traumatic cervical spinal cord injury (SCI). All branches are symmetrical. The decision node (blue square) indicates a choice facing the surgeon with regard to available surgical options for the base case. A chance node (green circle) represents an event with 2 possible consequences that are not under the surgeon's control. For each surgical strategy there are 6 possible outcomes based on surgical outcome (complicated or not complicated); disposition within the first 6 months after SCI (stay in the acute care setting or discharge from the acute care facility); and, if discharged, where the patient was discharged to (home or rehabilitation center). The terminal node (red diamond) indicates that patients have reached the 6-month time horizon from the date of SCI.

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