TRANSPORTATION OF PATIENTS WITH ACUTE TRAUMATIC CERVICAL SPINE INJURIES

RECOMMENDATIONS

Standards: There is insufficient evidence to support treatment standards.

Guidelines: There is insufficient evidence to support treatment guidelines.

Options: Expeditious and careful transport of patients with acute cervical spine or spinal cord injuries is recommended from the site of injury using the most appropriate mode of transportation available to the nearest capable definitive care medical facility.

RATIONALE

Definitive assessment, resuscitation, and care for the patient with an acute traumatic cervical spinal injury cannot be rendered at the accident scene. Optimal care for patients with spinal injury includes initial resuscitation, immobilization, extrication and early transport of the patient to a medical center with the capability for diagnosis and treatment (3-5,9,11). Delay in transportation to a definitive treatment center is associated with less favorable outcome, longer hospitalizations, and increased costs (7,8,11).

Several modes of transportation are available to transport the spinal injury patient, primarily land (ambulance) and air (helicopter or fixed wing plane). Selection of the ideal mode of transportation for an individual patient depends on the patient's clinical circumstances, distance, geography, and availability. The goal is to expedite efficient, safe, and effective transportation, without an unfavorable impact on patient outcome. These issues provide the rationale to establish guidelines for transportation of patients with acute traumatic cervical spine and spinal cord injuries.

SEARCH CRITERIA

A National Library of Medicine computerized literature search from 1966 to 2001 was undertaken using Medical Subject Headings in combination with “spinal injury” and "transport". The search was limited to the English language. The first search term (keyword and exploded subject heading) yielded 8,493 articles. The second search term (as keyword) yielded 12,437 articles. A search combining both search terms provided 44 articles. All 44 abstracts were reviewed. Additional references were culled from the reference lists of the remaining papers. Finally, members of the author group were asked to contribute articles known to them on the subject matter that were not found by other search means. A total of 13 articles were directly relevant to the subject of transportation of spinal injured patients. All articles provide Class III medical evidence. Pertinent articles are summarized in Evidentiary Table format.

SCIENTIFIC FOUNDATION

Safe, rapid transport of the spinal injured patient to a medical facility for definitive care has long been a fundamental tenet of Emergency Medical Service (EMS) care delivery. No randomized clinical trials to establish the necessity or effectiveness of this strategy have been performed. A search of the literature does not provide Class I or Class II medical evidence in support of this practice.

One of the basic principles of pre-hospital spinal care is the early transfer of the injury victim to a center with the resources and expertise to manage the patient with an acute cervical spine or spinal cord injury (3-5,9,11). Early complications can be prevented and improved neurological outcomes have been reported when early transfer to a specialized spinal cord injury

(SCI) center is accomplished (5,11). During transportation every effort must be made to limit untoward spinal motion and to preserve neurological function (12).

Several options exist for the transportation of patients to a definitive care facility. The selection of the mode of transportation is based on the patient's clinical status and what is reasonable and available to achieve the goals of rapid transfer while maintaining effective medical support of the patient and proper spinal immobilization for patients at risk.

In 1974, Hachen described the creation of a nationwide emergency transportation protocol for spinal injury patients implemented in Switzerland in 1968 (5). All SCI patients in Switzerland were immediately transported to The National Spinal Injuries Centre in Geneva by the Swiss Air Rescue Organization. In the ten-year follow-up of this protocol published in 1977, Hachen reported that early transport from the site of the accident to the SCI center under close medical supervision was associated with no patient death during transport. Prior to 1968 multiple deaths occurred during transport secondary to acute respiratory failure before definitive care could be provided. After 1968, patients were transported rapidly with an onboard anaesthetist who provided respiratory, cardiac, and hemodynamic monitoring, resuscitation, and nasotracheal intubation as necessary. The average time for the rescue operation was reduced from 4.5 hours to 50 minutes. There was a significant reduction in cardiovascular and respiratory morbidity and mortality. The mortality rate for complete quadriplegic patients dropped from 32.5% in 1966 to 6.8% in 1976; and for incomplete cervical cord injury patients from 9.9% to 1.4% during the same time period. Hachen concluded that survival and outcome of patients with acute spinal cord injuries was enhanced by a well-organized medical system, rapid medical-supervised transfer by helicopter to a specialized center followed by definitive care in a SCI facility for aggressive management in the intensive care unit setting (5,6).

Zach, et al, in 1976 described their experience with 117 acute SCI patients managed per prospective protocol in the Swiss Paraplegic Centre in Basle, Switzerland. All patients were treated in the ICU setting with aggressive medical management and cardiac and blood pressure support. Outcome was stratified by initial injury and time of admission after injury. Sixty-two percent of cervical spinal cord injuries managed in this fashion improved at last follow-up. No patient with a cervical level injury worsened, 38% were unchanged. Of patients who arrived within 12 hours of injury, 67% improved compared to their initial neurological condition. Fifty-nine percent of patients admitted between 12 and 48 hours of injury showed neurological improvement. When admission occurred after 48 hours of injury improvement was seen in only 50% of patients. The authors concluded that early transport and "immediate medical specific treatment of the spinal injury" appeared to facilitate neurological recovery (13).

In 1984, Tator et al reported their experience with 144 patients with acute spinal cord injuries treated between 1974 to 1979 at the Acute Spinal Cord Injury Unit (ASCIU) at Sunnybrook Medical Centre in Toronto, Canada. They found a marked reduction in both morbidity and mortality following acute spinal cord injury for the group of patients managed from 1974 to 1979 compared to a similar group of patients managed from 1947 to 1973, before the creation of a dedicated, regional Spinal Cord Injury Unit. Reasons cited for these improvements included earlier transport to the ASCIU following trauma and better definitive management upon arrival (10).

In a subsequent 1993 publication comparing ASCIU patients managed from 1974 to 1981 to their historical population of patients managed from 1947 to 1973, Tator and colleagues noted a statistically significant difference in duration of time from injury to arrival, 5 hours for ASCIU patients compared to 13 hours for the pre-ASCIU group. They found a significant decrease in

the severity of spinal cord injury, (65% complete cervical lesions compared to 46% for ASCIU patients) and noted fewer complications, shorter hospital stays, and lower expenses for patients managed under the new ASCIU paradigm. Their findings support the advantages of early transport to a regional, specialized SCI center for definitive comprehensive care of patients with spinal cord injuries (10, 11).

Burney, et al, reviewed the means of transport and type of stabilization used for all patients with acute spinal cord injuries transferred to the University of Michigan Medical Center from 1985 to 1988 to determine the effect of these variables on impairment and neurological improvement. Sixty-one patients were reviewed. Twenty-five patients were transported by ground ambulance (41%), 33 by helicopter (54%), and three patients by fixed-wing aircraft (5%). Forty-three patients (70.5%) had cervical spinal injuries, 11 (18%) thoracic spine injuries, and seven (11.5%) lumbar spinal injuries. Fifty-one patients (84%) were transferred within 24 hours of injury. A variety of standard methods of stabilization were used during transport. No patient suffered an ascending neurological injury as a result of early transport. Level of function improved before discharge in 26 of 61 patients (43%). Patients transported to the Medical Center within 24 hours of injury were more likely to show improvement (25 of 51) than those transported after 24 hours (1 of 10). There was no significant difference in the probability of improvement between ground (8 of 25) or air (18 of 36) transport. The authors concluded that acute SCI patients could be safely transported by air or ground using standard precautions. They found that distance and the extent of the patient's associated injuries were the best determinants of the mode of transport (3).

Rural areas reportedly account for 70% of fatal accidents and rural mortality rates for victims of motor vehicle accidents are four to five times greater than those found in urban areas.

A prospective cohort study by Boyd, et al, examined the effectiveness of air transport of major trauma patients when transferred to a trauma center from a rural emergency room (2). The study consisted of 872 consecutive trauma patients admitted after long-distance transfer. The authors found that air transport was associated with a 25.4% reduction in predicted mortality ($Z = 3.95$; $p < 0.001$). The benefit of helicopter EMS transport was realized only in major trauma patients with a probability of survival of less than 90%. Thus, the benefits identified with early helicopter EMS transport were directly related to injury severity. It is unclear whether these findings can be extrapolated to spinal injured and/or spinal cord injury patients, since the authors did not stratify injuries by body systems in their report.

Neither land nor air transport has been reported in the literature to negatively impact the outcome of spinal injured patients when properly executed. One note of caution was offered by Armitage, et al. They described four spinal injured patients who developed respiratory distress/failure during airplane transport. They noted that since patients with cervical spinal cord injuries may have severely reduced pulmonary performance, measures to optimize oxygenation, humidification and pulmonary function in cervical spinal cord injury patients should be undertaken, particularly during air transport. (1)

SUMMARY

The patient with an acute cervical spinal or spinal cord injury should be expeditiously and carefully transported from the site of injury to the nearest capable definitive care medical facility. The mode of transportation chosen should be based upon the patient's clinical circumstances, distance from target facility, geography to be traveled, and should be the most rapid means available. Patients with cervical spinal cord injuries have a high incidence of airway

compromise and pulmonary dysfunction, therefore respiratory support measures should be available during transport. Several studies cited suggest improved morbidity and mortality of spinal cord injured patients after the advent of sophisticated transport systems to dedicated SCI centers. These studies all provide Class III medical evidence on this issue.

KEY ISSUES FOR FUTURE INVESTIGATION

Development and refinement of transportation protocols for patients with cervical spine and spinal cord injury should be undertaken and could be accomplished using a large prospectively collected data set. From these data case-control or comparative cohort studies could be structured to generate Class II evidence.

EVIDENTIARY TABLE

First Author Reference	Description of Study	Data Class	Conclusions
Tator et al, 1993, *Surg Neurology*	A study of 201 ASCI patients, ICU care, hemodynamic support compared to 351 prior patients	Class III	Less severe cord injuries due to immobilization, resuscitation and early transfer to ICU setting.
Armitage et al, 1990, *BMJ*	Case reports of four patients who developed respiratory problems during airplane transport.	Class III	Airplane air is less humid and measures to optimize humidity and pulmonary function travel in high cervical injury patients may be required
Boyd et al, 1989 *J Trauma-Injury Infection & Crit Care*	A prospective cohort study to determine the effectiveness of air transport for major trauma patients when transferred to a trauma center from a rural emergency room.	Class III	Patients with severe multiple injury from rural areas fare better with helicopter EMS than ground EMS
Burney et al, 1989 *J Trauma-Injury Infection & Crit Care*	Retrospective review of the means of transport and type of stabilization used for all patients with ASCI.	Class III	Acute SCI patients can be safely transported by air or ground using standard precautions. Distance and extent of associated injury are the best determinants of mode of transport.
Tator et al,1984 *Can J of Surg*	A retrospective review of results of innovations between 1974 to 1979 at Sunnybrook Medical Centre in Toronto.	Class III	Patients transferred to the SCI unit earlier, with consequent marked reduction in complications and cost of care.
Hachen, 1977 *J Trauma*	A study of 188 ASCI managed in centre ICU, aggressive treatment of hypotension, respiratory insuffiency	Class III	Reduced morbidity and mortality with early transfer, attentive ICU care and monitoring, and aggressive treatment of hypotension and respiratory failure.
Zach, et al, 1976 *Paraplegia*	A study of 117 ASCI at Swiss Center, ICU setting aggressive BP, volume therapy. Rheomacrodex x 5d Dexamethasone x 10d	Class III	Improved neurological outcome with aggressive medical treatment. Better outcome for early referrals.
Hachen,1974 *Paraplegia*	Retrospective review of effectiveness of emergency transportation of spinal injury patients in Switzerland. Between 1965-1974 all SCI patients were immediately transported by air to SCI center. Mortality reduced to zero, during transport. Average time for the rescue operation reduced from 4.5 hours to 50 minutes. h Significant reduction in cardiovascular and respiratory morbidity.	Class III	Mortality and morbidity of patients with acute spinal injury is reduced by a well-organized medical response with smooth and rapid transfer by helicopter to a specialized SCI center.

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