

Management of Spinal Cord Injury

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Family physicians can help prevent spinal cord injuries by patient education about alcohol, drugs, seat belts, and football safety rules. Immobilization at the site of injury is essential to prevent incomplete cord injuries from becoming complete. Treatment is urgent; hemorrhagic necrosis of the cord is reversible only up to four hours after injury. Physicians must inform patients and families that regional spinal injuries centers provide the best care, with lowest total costs, and shortest hospital stay. Initial treatment includes immobilization, with or without surgery, prophylactic anticoagulants, and sometimes steroids and local hypothermia. Intermittent catheterization has revolutionized bladder control and reduced the incidence of infections. The most common causes of death are renal failure and pulmonary complications. Rehabilitation aims include the prevention of complications, sitting stability, strengthening non-paralyzed muscles, and providing equipment for maximum function. Psychologists, who work with families as well as patients in developing coping strategies, are important members of rehabilitation teams. Seventy percent of paraplegics return to the community within six months of injury, and nearly 50 percent achieve satisfactory sexual activity.

Spinal cord injury does not occur often. But it is an emergency of the first magnitude, and unskilled handling can compound the disaster. Most physicians are unlikely to be familiar with the details of management because few cases present to any one physician during a lifetime. The family physician may be the first on the scene and must know the basic principles of up-to-date treatment. In the past decade, results of research have led to changes in traditional methods of management and a better outlook for the victims. This paper presents an overview and current recommendations

for patients with spinal cord injuries, both in the acute stage and during rehabilitation.

Most of the 13,000 cases a year in this country are young men in their late 20s. Alcohol is a factor in about 60 percent and drug addiction has been reported in 30 to 80 percent of cases. Motor vehicle accidents are responsible for about 45 percent of cord injuries, particularly when seat belts are not worn, or not worn properly. The incidence of spinal cord injury declined markedly when seat belts became compulsory in Australia.¹ Lying down longitudinally in a truck or station wagon is a particularly dangerous position.

Sports, particularly football, water sports, and trampolining, are responsible for about one third of spinal cord injuries. Gunshot and stab wounds of the cord occur most frequently among school

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dropouts and the unemployed. In older people, falls with hyperextension of the neck can cause cord injury because the cervical canal is already narrowed by osteoarthritis and spondylosis.² Not surprisingly, the highest incidence of cord injuries is in the spring and summer, and on weekends.

There are more spinal cord injured patients alive today than ever before, and 70 percent of patients with paraplegia will become independent eventually. This significant increase in the survival rate is attributed to more accurate diagnosis and better emergency handling and transport. For the same reasons, the incidence of incomplete spinal cord injury, in which there is some preservation of sensory or motor power below the lesion, is also increasing. The improved long-term survival rate is largely due to better bladder care and antibiotics.

At the Accident

The possibility of spinal cord injury must be thought of in any accident, even if the patient is not paralyzed. Too many patients with incomplete lesions, who can move their limbs at the accident site, develop complete lesions with paralysis by the time they reach the hospital.

Suspect injury to the spinal cord, vertebral column, or both in any patient with impaired consciousness, severe pain in the neck or back, facial, head, or neck injuries, and inability to move. If conscious, the patient can be asked about sensation in the trunk and extremities. Unexplained hypotension or bradycardia is a sign of sympathetic trunk injury and the acute cervical cord syndrome. Paradoxical (diaphragmatic) breathing is a sign of cord injury.

Life support must be maintained without altering the position of the head or neck. The airway can be controlled by the upward mandibular thrust or chin-lift, and suctioning of the oropharynx. If respiratory insufficiency develops due to paralyzed intercostal muscles, mouth-to-mouth respiration may be needed. Neurogenic shock should be treated with intravenous fluids, elevation of the stretcher foot, and circulation supporting drugs if there is no response to the initial measures.

The victim must be extricated from a damaged vehicle with extreme care, and only by trained personnel. If it is necessary to lift the patient, the ideal number of helpers is four; one person is responsible for supporting the head and keeping it in alignment with the neck and spine, while three persons stand on one side and cradle the patient in their arms.³ If a special craniospinal splint, or a stretcher designed to eliminate rolling and sliding, is not available, the patient must be immobilized on a firm surface such as a door, and slightly hyperextended to prevent flexion. The translucent frame used in some ambulances can be placed on a hospital cart for transport within the hospital. The patient should not be moved from the stretcher or frame except for transfer into bed in the hospital where treatment will be received.

Diagnosis

The first neurological examination is very important for providing baseline information. If semiconscious, the patient is likely to be restless and uncooperative, and the head must be kept immobilized as described above. Examination of the level of consciousness should be performed first. Individual muscle function should be assessed, especially in the upper limbs. All reflexes, including the bulbocavernosus and anal reflex must be tested. Sensory functions to be evaluated include bladder function, bowel sounds, respiratory function, penile engorgement or priapism, as well as cutaneous sensation. X-ray studies should be performed under the physician's personal supervision because any movement is potentially hazardous.

Family physicians must recognize their own limitations in such situations and not hesitate to call a consultant neurologist to the emergency room. The complete examination must be repeated after reduction or traction, and after recovery from traumatic shock or unconsciousness.

It is very important to talk to the patient's relatives at this stage and keep them fully informed about the paralysis and available methods of treatment. Litigation is much more likely if they have not been informed about the alternatives,

Table 1. Regional Spinal Injuries Centers in the United States

Spain Rehabilitation Center, Birmingham, Alabama
Good Samaritan Hospital and St. Joseph's Hospital, Phoenix, Arizona
Santa Clara Valley Medical Center, San Jose, California
Rancho Los Amigos Hospital, Downey, California
Craig Rehabilitation Hospital, Englewood, Colorado
Northwestern Memorial Hospital and Rehabilitation Institute of Chicago, Chicago, Illinois
University of Minnesota, Minneapolis, Minnesota
Institute of Rehabilitation Medicine, New York, New York
Texas Institute for Rehabilitation and Research, Houston, Texas
Woodrow Wilson Rehabilitation Center, Fishersville, Virginia
Department of Rehabilitation Medicine, University of Washington, Seattle, Washington

such as laminectomy, fusion stabilization, and traction, and the pros and cons of each method.

Pathophysiology

In 90 percent of cases the spinal cord is not transected at the time of injury. Within one hour an irreversible process of hemorrhagic necrosis begins which destroys the damaged cord. Arteriolar vasomotor paralysis, swelling of the cord, and subsequent compression of the nutrient arteries reduce perfusion and oxygen levels. Hypoxia leads to necrosis and axonal degeneration. The end result is central grey necrosis, with cystic and vacuolar changes of the white matter.

These changes are *reversible* up to four hours after injury. Animal experiments have shown that local hypothermia to reduce tissue oxygen needs, and systemic steroids to reduce edema, have provided improved results if instituted early enough.

The syndrome of acute central cervical cord injury occurs when the vertebral column is undamaged, and there is disproportionately greater paralysis of the upper extremities than the lower. Because the axons carrying motor impulses to the upper extremities lie medially, these are most affected by bleeding in the central grey matter. The syndrome often occurs in patients with degenerative disc disease, and is probably due to hyperextension.²

Treatment Location

In a general hospital setting, decubitus ulcers often progress rapidly, bladder control is less than ideal, and flexion deformities develop because of incorrect positioning of the patient in the early stages. These problems take months of care to remedy once they have been allowed to develop. "It is sometimes said that patients with spinal injuries are too sick to be moved to major centers. Actually, they are too sick to be safely managed in small hospitals."⁴

Experience worldwide has shown that by far the best care for patients with spinal cord injury is in special spinal injuries centers. The mortality rate for complete tetraplegics in Switzerland has dropped from 32.5 to 6.8 percent since the introduction of special spinal care units and helicopter transportation.⁵ Centers have been set up in each region of the United States (Table 1) and they provide experts in paraplegia, continuing team care, acute and rehabilitation facilities at one location, as well as the company of other spinal cord injured patients. It has also been shown that the complication rate increases proportionately to the delay of admission to an acute spinal injuries center.

The family physician has a major responsibility to inform patients and their families about these centers, and when appropriate to arrange air transportation and admission. Telephone consultations with center staff are appropriate from the time of injury.

Initial Treatment

1. Move the patient every two hours, even before the diagnosis is established, to avoid the development of decubitus ulcers.

2. Use a respirator in cases of high cervical (C2-3) injury.

3. Immobilize an incomplete lesion to prevent loss of further function. Perfect alignment of vertebrae is less necessary when the lesion is already complete. Immobilization can be achieved by Gardner Wells traction tongs attached to the skull with eight to ten pounds traction, on a turning frame or bed. Another method which avoids the risk of surgery and anesthesia is the halo vest, and an added advantage is early mobilization.

4. Steroids. Large doses of dexamethasone given early after injury reduce edema of the cord and are often used routinely. However, some paraplegists do not use them because electrolyte imbalance and stress ulcer often develop.

5. Anti-coagulants. In some centers, heparin is given for one week followed by warfarin (Coumadin) for three months to avoid venous thrombosis.

6. Do not give narcotics because of the very real risk of addiction.

7. Bladder care. "The indiscriminate insertion of an indwelling catheter immediately into the paralyzed bladder during the acute stage of spinal cord injury should be considered as much a mismanagement as previously a suprapubic cystostomy."⁶ However, it is important not to let the bladder overdistend in the early stages, because this may abolish the rhythmic contractile activity which is present, even in the denervated bladder. Indwelling Foley catheters may be used for the first three to four days when urine output is high, and then changed to a program of intermittent catheterization. This technique has been proved to prevent bladder infection and reduce its incidence from 85 to 6 percent.⁷ Nursing care must be scrupulous, and the patient must be educated in the prevention of infection transmission from bowel to urethra. Painful bladder spasms and voiding difficulties are treated with anti-spasmodic drugs. A useful combination is dantrolene sodium or baclofen, with diazepam.

8. Surgery. Decompression by laminectomy is recommended by some to prevent pressure on the spinal cord due to edema and hemorrhage, but patients with complete lesions show no neurological improvement, even when decompression is done

early. Surgery may cause further severe damage, increased shock, and neurological deterioration. Many neurosurgeons feel that such a radical procedure cannot be justified just because there is nothing to lose, but there is general agreement that foreign bodies within the spinal canal must be removed, and that deteriorating neurological function is a sign for intervention. Unstable, fractured spinal columns may require fusion, and the advantages of this are that early mobilization and rehabilitation are possible. Local hypothermia, by irrigating the exposed cord with ice water, has produced significantly better results in experimental animals, but has not been conclusively proved beneficial in patients.

9. Continue nasogastric suction and intravenous fluids until the initial paralytic ileus is over.

Complications

The average number of complications is seven per patient, and the number associated with surgical treatment is four per patient.

Muscle spasticity and pain. Flexion contractures may result from the spasticity. Surgical procedures often performed are obturator neurectomy to relieve adductor spasm, Achilles tenotomy for spastic talipes equinovarus, and section of anterior and posterior nerve root columns. Some patients can learn to use the spastic muscles, and converting the spasticity to flaccidity by surgery may make the development of decubiti more likely. Dantrolene sodium or baclofen, given concurrently with diazepam, relieve painful flexor spasms effectively.

Decubitus ulcers. These are the most common reason for readmission to hospital. Hyperemia of the skin is the earliest sign and it may appear after only 30 minutes in one position. Patients with wheelchairs must be taught how to relieve pressure on the buttocks every half hour.

The new paraplegic develops cardiac failure and pulmonary edema easily, and fluid control is important. A diuresis often occurs on the third or fourth day. Paralysis of thoracic muscles often leads to hypoventilation and pneumonia.

Calcium imbalance causes bone loss and hypercalcemia, especially in 12 to 20 year olds. Calcium stones frequently result from hypercalciuria.

Deep venous thrombosis occurs in 12 to 25 percent of patients, especially in the postoperative phases. It leads to pulmonary embolism and death in up to 20 percent of these. The symptoms are masked in quadriplegics because of paralysis of the respiratory muscles.

Autonomic hyperreflexia is a cause of considerable difficulty during rehabilitation. Vascular pooling and hypotension when first sitting up can be lessened by wrapping the legs and using an abdominal binder. Paroxysmal hypertension is often stimulated by bladder distension. Autonomic blocking agents may be needed.

Genitourinary complications cause most of the morbidity and early death of cord damaged patients. Intermittent catheterization and antibiotics have revolutionized care and lowered the mortality rate. Incontinence, infection, and bladder spasms occur most frequently, and can be satisfactorily controlled with long-term antibiotics and combinations of anti-spasmodics. Forty percent of patients may progress to renal failure.

The list of possible complications is varied and practically endless. It includes fecal incontinence, heterotopic ossification, adrenal insufficiency, and painless pancreatitis. Psychologic problems, often severe, are discussed later.

Prognosis

The preservation of sensation around the anus demonstrates an incomplete spinal cord injury and is a good sign that some recovery is possible in the lower extremities. The presence of somatosensory evoked potentials is also a sensitive early indicator of good prognosis and return of function. During the acute period, motor function is more likely to improve than sensory function. Forty percent of patients admitted to the hospital will show improvement.⁸

Education and vocational training is necessary for home living and making a family life possible. Up to 75 percent of paraplegics, but only 10 to 40 percent of quadriplegics, are able to lead a fairly

normal life and work by the tenth anniversary of the injury. Employed cord-injured patients have fewer complications, better long-term survival, and greater motivation for follow-up than the unemployed patients with this injury.

The final mobility achieved by women is often better than that achieved by men. This may be due to the fact that men have more severe depression, and less response to rehabilitation. The outlook for rehabilitation is also poor in patients with social problems.

Mortality

The mortality rate in the first six weeks is five to ten percent, and the overall mortality rate is 49 percent after 25 years. However, in one series, 53 percent of the "avoidable" deaths before the sixth anniversary were due to suicide. The most common cause of death (36 to 43 percent) is renal failure, and the second most common cause is pulmonary complications, particularly in quadriplegics.

Rehabilitation

The aims of rehabilitation are to prevent complications, establish sitting stability, strengthen musculature, provide equipment for maximum function, and expect the patient to return home as a participating member of the community.

In the earliest stages, physiological positioning of paralyzed joints, alignment of the spine, and alternating the supine and prone positions on a Stryker frame are possible. Later, deep breathing exercises and active movements of the non-paralyzed limbs are necessary. Finally, passive movements of the paralyzed limbs are started, beginning very gently to avoid spasm. The sooner muscle strengthening exercises begin, the less disuse atrophy there is to overcome. If joint contractures and decubiti are prevented during the first six weeks after injury, the patient's participation in rehabilitation will not be delayed. The average

length of stay in a rehabilitation hospital is 6 months for paraplegics and 12 months for quadriplegics.

Psychologic Rehabilitation

Psychiatrists and psychologists are often members of treatment teams for cord injured patients; they are able to help patients with coping behavior. A useful method of treatment is to assess the strategies that the patient has used in past stressful episodes.

Denial and depression are appropriate and adaptive, and may last for many years, but extended depression or grief is counter-productive to post-hospital adjustment. "The emotional acceptance of spinal cord injury appears to depend on the patient's ability to find and experience options which permit the patient to believe that she or he can still realize many hopes for the future while confined to a wheelchair."⁹ Psychotropic drugs must be carefully chosen, and those with autonomic system side effects avoided because of their effect on the bladder and blood pressure control.

Setting realistic rehabilitation goals is another valuable aim of psychologic rehabilitation which it is hoped will lower the subsequent suicide rate.

The Family

The most consistent changes towards deeper depression or greater elation result from events involving the important people in the patient's life. The value of interpersonal relationships should not be underestimated.

It is imperative that patients return to the community early, so that ties to family, friends, and school can be preserved. Family members can also be encouraged to assist in the patient's care and treatment as early as possible, but this may be difficult in a center far from the patient's home.

Psychological and social counseling are needed immediately after the injury, and over the long

term, by the family as well as the patient.

Sexual information is a normal part of rehabilitation. Sexual and emotional needs can occur even without genital sensation or function, and if these needs are met, the patient adjusts better to the disability. Ninety-seven percent of a group of cord injured veterans had attempted sex post injury, and 41.3 percent had found it "satisfactory." The average interval of time after injury before it was attempted was 22 months. No problem was experienced by 91.2 percent of the veterans in finding partners.¹⁰

Costs

The development of federally funded regional spinal cord injury centers throughout the United States by the Rehabilitation Services Administration was based on the hypothesis that such a system would be cost effective. It has been shown that "system" patients' total initial hospital and rehabilitation costs were reduced by 23 percent compared with "non-system" patients.¹¹ Total mean costs in 1976 for acute care and rehabilitation (approximately six months) were estimated to be \$17,394 for system patients, and \$22,347 for non-system patients.¹²

Total costs for the first year must also include physician fees, special equipment, and home modification, such as door widening or ramp construction. Webb estimated \$35,676 total cost for the first year in 1974.¹³

When the costs of lifetime care are added, the figure becomes astronomical. A 1974 estimate of the total cost of spinal cord injury was \$248,628,790.¹⁴ This does not include the loss of wages, legal services, insurance administration, nor the incalculable amount of human misery.

System hospitals are able to achieve rehabilitation for discharge to the community quicker than non-system hospitals. Length of stay has been estimated at 20.4 percent less for system hospital patients,¹¹ and is a major benefit of the spinal cord injury centers.

Any patient may regress if subsequent long-term care by community professionals is not exemplary. Bedbrook regards bedsores, urinary

tract infections, and contractures as iatrogenic diseases.⁸

Summary

Most of the causes of spinal cord injury are preventable, particularly if alcohol and drugs of addiction are avoided, seat belts are used correctly, and football safety rules are followed. Patient education by family physicians could be a major factor in prevention.

In patients with suspected spinal cord injury, immobilization at the accident site is essential to prevent incomplete cord injury from becoming complete. Regional spinal injuries centers with teams led by paraplegists provide the best acute and rehabilitation care. Transfer to a center, perhaps by air, is recommended as soon as possible, because hemorrhagic necrosis is reversible only up to four hours after injury.

The mortality rate is 5 to 10 percent within the first 6 weeks, and 49 percent after 25 years. Renal failure and pulmonary complications are the most common causes of death.

Initial treatment includes immobilization by traction, halo vest, or surgery. Local hypothermia of the cord may be beneficial. Steroids reduce edema of the cord and may limit hemorrhage necrosis, but can cause stress ulcers. Prophylactic anticoagulants lower the incidence of deep venous thrombosis. Drugs with few anti-cholinergic side effects must be used.

Complications include decubitus ulcers, flexor spasms and contractures, pulmonary edema and infection, autonomic dysreflexia, osteoporosis, psychological problems, and urinary tract infections and calculi. Intermittent catheterization is the method of choice for bladder control.

The aims of rehabilitation include preventing complications, preserving function in undamaged muscles, providing equipment for maximum function, and helping the patient become a participating member of the community.

Prognosis and results of rehabilitation are better for women than men. Seventy percent of paraplegics return to the community within six months, and 75 percent find employment within ten years. Nearly 50 percent achieve satisfactory sexual activity. Denial and depression may last for many

years. Involvement of the family in the patient's care at an early stage is helpful. Families as well as patients need psychologic help in developing coping strategies.

Costs and length of hospital stay are less in special spinal injuries centers than in general hospitals. Scrupulous care is necessary in long-term follow-up to prevent complications.

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