

New focus on spinal cord injury

What is believed to be the first intensive care area specifically designed for treatment of patients with acute spinal cord injuries has just opened in Chicago.

The new, 20-bed unit at Northwestern Memorial Hospital began receiving patients in February. It is another dimension of the 8-year-old Midwest Regional Spinal Cord Injury Care System. With the sophisticated monitoring equipment and other resources of the new unit, physicians expect to learn more about the destructive changes that occur in the first few hours after spinal cord injury and what may be done to counteract them.

Already, says Paul R. Meyer, Jr, MD, director of the Midwest system, survival with less permanent damage is being achieved in this and 13 other spinal cord injury care systems to which the federal Rehabilitation Services Administration began supplying financial support during the last decade. These better clinical results, he suggests, stem from advances in research and treatment involving such patients in recent years. More specifically, they are due partly to changes in emergency treatment at the accident scene, such as:

- Prompt recognition by emergency personnel of actual or potential spinal cord damage.
- Better techniques for removing persons with possible spinal cord damage from the scene.
- Swifter and safer transportation of the injured to early-care facilities, usually trauma centers.
- Radio consultation with physicians expert in care of spinal cord injury.
- Efforts to prevent blood pressure (BP) within the spinal cord from dropping, such as positioning the head lower than the rest of the body; administering fluids, including plasma expanders; and administering drugs to improve cardiac output and peripheral circulation.
- Maintaining oxygen saturation of the cord area (if indicated from monitoring of peripheral arterial gases) to forestall cord degeneration, including administration of oxygen via nasal mask and perhaps continuous positive airway pressure techniques to drive oxygen across cell membranes in the alveoli.
- Immobilization of the damaged cord area.

Says Meyer, who is also associate professor of orthopedic surgery at Northwestern University Medical School and attending physician in Northwestern Memorial's orthopedic surgery department: "The first



Dr Meyer with patient.

few hours after an injury to the spinal cord are critical. The cord covering is tough and rarely completely severed. Yet bleeding, pressure from fractured vertebrae, and other factors cause self-destruction. Within four hours, the patient may lose much neurological function below the injury site. After 48 hours, the process is often irreversible."

The rapidity of transport and the total number of spinal cord injury patients brought to Chicago and the other system locations is increasing each year, says Meyer. He predicts that, with the sharing of clinical findings through the 14 systems' National Data Research Center (at Good Samaritan Hospital, Phoenix, Ariz) and the use of sophisticated new monitoring equipment like that in Chicago, medical personnel treating spinal cord injuries eventually will have considerable information about what is happening to the cord and what should be done about it.

Next week: Research on spinal cord injury.

Such injuries usually are categorized as complete or incomplete. A complete lesion ends sensation and paralyzes muscles below the injury level; at present, little physical improvement can be expected. On the other hand, an incomplete lesion at least initially allows some voluntary movement or sensation and the prognosis is somewhat better.

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Complete Lesions Declining

In 1979, 55% of patients referred to the Midwest system had complete and 45% incomplete lesions. For the past year, due in part to advances in treatment, the proportion of patients with complete lesions declined from more than 50% to 39%, Meyer told an American Academy of Orthopaedic Surgeons meeting audience this month in Las Vegas.

J. Paul Thomas, PhD, director of the medical research office for the Rehabilitation Services Administration's National Institute of Handicapped Research, Washington, DC, says that "over the last decade, several spinal cord injury programs have observed a change in the ratio of [newly admitted] paraplegic and quadriplegic patients from 65% and 35%, respectively, to 50% and 50%. Many centers [not within the various systems] are experiencing 65% to 70% quadriplegics among their new patients, but our [Phoenix] data base indicates the 50% split."

The death rate is about 6% during the first year after injury, adds Meyer, dropping to 2% in the second, third, and fourth years, and to 1% by the fifth year.

Prevention of additional spinal cord injury, which can mean that an incomplete lesion remains incomplete, has become a paramount consideration in acute treatment. At Rancho Los Amigos Hospital, which

with the Los Angeles County-University of Southern California Medical Center became the 14th Rehabilitation Services Administration-sponsored regional spinal cord injury care system slightly more than a year ago, administrative director Rodney H. Adkins, PhD, says: "At the time that Rancho began to admit spinal injury patients, there were few cases of incomplete lesions. Emergency procedures are now being emphasized nationwide to prevent further injury to patients with spinal injuries while they are being transported to hospitals. This means that the injured individual's chance for less deficit and better functional capability is increased.

"However," Adkins says, "because of the increase in incomplete lesions [and increased survival in the complete lesion group], the complexity of the rehabilitation process is increasing. Also the increased sophistication of emergency care has improved the survival rate among those sustaining high cervical lesions. As a result, there are many more respirator-dependent persons who require treatment."

The Chicago system, says Meyer, draws on the resources of Northwestern University Medical School, the Illinois Department of Public Health, Northwestern Memorial Hospital, and the Rehabilitation Institute of Chicago. It is organized to receive patients from within a 325-km radius extending into five surrounding states on an emergency basis at any time of day. Whenever possible, of course, this and the 13 other systems like to receive spinal cord injury patients within the first few hours after the injury.

For some areas, resources like Military Assistance to Safety and Traffic (MAST) helicopters are available (*JAMA* [MEDICAL NEWS] 1971;217:1311, 1974; 227:603, 1976;235:465). At the Chicago center, resources are available through the Illinois Emergency Medical Services System established ten years ago.

(The idea of acute spinal cord injury treatment centers generally is attributed to the late Sir Ludwig Guttman, MD, of Stoke Mandeville Hospital, Aylesbury, England. Sir Ludwig, a neurosurgeon, was knighted for his work in establishing such centers and for his efforts that led to an International Olympiad for Paraplegics.)

In the acute phase of care—at the trauma center or one of the spinal cord injury centers—a rule of thumb has been that, the higher on the spinal cord the injury occurs, the more grave the outlook. Above the fourth cervical segment, such injury often is fatal.

With an injury at the fifth cervical level, the patient is left almost totally dependent on other persons; he or she is quadriplegic, though able to sit in one of the newer wheelchairs, and requires ventilator assistance to breathe. Injury involving the sixth or seventh cervical segments also commonly results in varying degrees of quadriplegia, respiratory problems, and dependence on other persons. But the patient usually is able to use a wheelchair, has almost normal shoulder and elbow function, and is able to perform some tasks with the hands, frequently with

AMA-IYDP International Year of Disabled Persons



Particular attention is being focused on patients with spinal cord injuries at this time because 1981 is the International Year of Disabled Persons (IYDP).

The United Nations designates an "international year" on behalf of a particular group every two years. Previous years have focused on the dignity, human rights, and well-being of women and children. The IYDP is symbolized by pulling together to help one another.

In this country, the US Council for the IYDP—of which the American Medical Association is a national partner—is working with the 50 state governors, more than 1,600 communities, and nearly 300 national organizations. Goals for the disabled include expansion of opportunities in education and employment; greater social, cultural, and recreational participation; access to housing, buildings, and transportation; and accident and disease prevention.—P.G.

the assistance of forearm and hand splints.

If the injury is at the eighth cervical segment or involves upper thoracic segments, the patient may have use of the hands, probably will be paraplegic, and will be incontinent as are those with injuries at higher levels.

Upper extremity function may be close to normal if the injury is below the second thoracic segment, but not until the injury is at approximately the region of the 12th thoracic or first lumbar segments can the patient be expected to move about fairly well with the aid of crutches and braces.

Although the level of involvement may move up from, for example, the sixth to the fifth cervical segment (probably because of edema) after the patient has been brought to the hospital, Meyer says that aggressive therapy—perhaps with corticosteroids—and careful handling often will help to resolve the cord edema and “bring it back to the C-6 level.”

The gray matter, filled with neurons and located within the peripheral axon- and fiber-filled white matter of the spinal cord, is believed to be especially metabolically active and sensitive to injury. Some investigators believe this is due to the vascularity of the area. In any case, during the first few hours after severe spinal cord injury, blood circulation to the gray matter is curtailed.

This was demonstrated, Meyer points out, by Northwestern Neurosurgical Research Laboratory workers using fluorescein dye. In normal animal spinal cords, the dye was clearly visible in the gray matter. However, immediately after contusion of the

cord, no dye could be observed in this area. Within four hours of the injury, an extensive amount of dye was seen in the damaged segment's gray matter, suggesting that hemorrhaging was beginning.

Posttrauma studies of the spinal cord by a variety of investigators in recent years have produced reports of swollen axons, erythrocyte extravasation from the central necrotic area outward toward the white matter, hemorrhage in the gray matter (with edema, capillary collapse, hypoxia, and necrosis as its aftermath) also spreading into the white matter, and eventual vacuolation of the myelin sheath.

Thus, at the trauma centers where spinal cord injured patients are usually taken first, personnel are learning to administer dexamethasone (50 mg intravenously [IV]) as an anti-inflammatory agent, mannitol (20% strength, 500 mL initially, administered IV), and—occasionally for edema and to improve capillary blood flow—dextran 70 in a 0.9% sodium chloride solution. However, opinions differ about these therapies, with some physicians believing that neither mannitol nor corticosteroids are of value in treating acute or chronic spinal cord injuries.

Patient Transport

When the patient is transferred from a trauma center to the Chicago system, physicians may have a number of directions for transport personnel. In addition to monitoring vital signs, keeping the patient as quiet and comfortable as possible, and coping with any life-threatening developments, they may be

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Mounting statistics on spinal cord injuries

As many as 10,000 persons may sustain spinal cord injuries in the United States this year, adding to the approximately 200,000 Americans who have survived this type of trauma.

These figures are based on data from a survey recently completed by the Research Triangle (NC) Institute for the National Institute of Neurological and Communicative Disorders and Stroke (NINCDS). But statistics vary, and investigators from the Southeastern Regional Spinal Cord Injury Care System at the University of Alabama in Birmingham note that there are even disparities in the scientific literature over the length of “long-term” survival (*Arch Neurol* 1980;37:707-708).

“Recovery” from spinal cord injury also is difficult to define, points out Jess F. Kraus, PhD, Department of Community Health, University of California School of Medicine, Davis (*J Neurosurg* 1980;53[suppl]:3-10). Furthermore, there are virtually no data on short-term mortality because “these fatalities are coded from the death certificates according to external cause (such as motor vehicle accidents), instead of by

the nature of the injury.”

Whatever the situation, NINCDS officials say, even the highest estimates of yearly incidence and prevalence “do not reflect the full impact of spinal cord injury on its victims and on society. This catastrophic disease causes physical and emotional deprivation out of all proportion to the numbers of people affected.”

Moreover, in the economic sense, the impact of spinal cord injury is almost incalculable. Paul R. Meyer, Jr, MD, codirector and founder of the Midwest Regional Spinal Cord Injury Care System, says that the initial few months of hospital care can cost from \$56,000 to \$80,000, and lifetime costs may total \$500,000 or more. According to NINCDS officials, as of mid-1980, “total annual costs to society were estimated at more than \$2 billion in the United States alone. Societal and vocational constraints . . . exact an additional toll in diminished personal happiness and productivity.”

Another aspect of spinal cord injury's devastating impact: two thirds of the victims in this country are 30 years old or younger.—by PHIL GUNBY

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directed to:

- Administer dexamethasone and mannitol IV en route.
- Administer oxygen nasally (done without exception in quadriplegic patients), insert nasogastric tubes to prevent emesis, or catheterize the patient to monitor urinary output.
- Protect the injured cord area with a back board, sand bags, or other traction or splinting. (Meyer himself has developed an adjunctive splinting device, patented through Northwestern University, for trans-

porting patients with suspected or acute cervical spine injuries. About 300 of these devices have been manufactured and sold.)

To transport spinal cord injury patients over distances up to about 75 km, critical care vans with stand-up room for cardiopulmonary resuscitation and IV-administration equipment and carrying telemetry equipment usually are employed. For distances from 75 to 125 km, helicopters often are used and for distances greater than 125 km, fixed-wing aircraft are obtained.

Once a patient arrives at the intensive care area of

It's nothing new, unfortunately, for the VA

What happens to a marriage when the husband sustains a spinal cord injury? Some studies indicate about one in ten ends in divorce. But a Veterans Administration study suggests almost three in ten come to an end, a figure roughly comparable with that for the US population as a whole.

These data are from researchers at the Wood (Wis) VA Hospital, who have been studying such problems. Of 333 marriages studied six years ago, 27% ended in divorce and another 2% of the couples were separated by the time the investigation was concluded.

This study is just part of the research carried out by the VA system of specialized care for veterans with spinal cord injuries. Between 6,000 and 7,000 such patients undergo treatment in VA centers in any given year.

Before World War II, there was little information on the care of spinal cord injury victims because they did not survive very long. But during and after World War II, 2,000 veterans with spinal cord injuries returned to US Army general hospitals. By 1946, the VA had assumed responsibility for most of these patients, and the Paralyzed Veterans of America also was founded the same year.

The VA now operates 19 spinal cord injury centers in its facilities. More than 1,000 new patients with spinal cord injuries are admitted each year. Of these 1,000, perhaps 20 are not veterans; care of nonveterans has been authorized since May 1975 as a humanitarian service in the absence of appropriate non-VA facilities.

Almost half the patients admitted to military hospitals with spinal cord injuries are transferred to VA facilities within 30 days. There are also more than 33,000 outpatient visits annually for treatment of spinal cord injury-related problems as well as 16,000 visits to patients' homes by hospital-based home care personnel from 11 centers. In 13 centers there are

"home environment clinics," which are really apartments where spinal cord injury patients can experience noninstitutional "transitional living" before going home.

Within the VA, particular attention is focused on the problems of long-term care of spinal cord injury. Officials point out that the most common site for infectious disease is the urinary tract, and renal failure is the most frequent cause of death.

Among causes of renal disease in this patient population in addition to urinary tract infections are amyloidosis, lithiasis, and hypertension. All but three VA centers have urodynamic laboratories. The staff at the Long Beach, Calif, center—the first to provide dialysis service for these patients—has found that spinal cord injury patients with renal problems can be maintained on long-term hemodialysis with a survival rate "similar to that of other high-risk groups on dialysis."

Besides research and therapy, the VA has a subspecialty area of training for its physicians in spinal cord injury "because a separate medical specialty in spinal cord care does not exist." This now is a two-year program with training in orthopedic, plastic, and neurological surgery; anatomy; neuroanatomy; urology; physiology; and internal and rehabilitative medicine. Eight physicians started the program last July, joining one who began in 1979, and the VA now is recruiting eight additional physicians for this program.

The 19 spinal cord injury centers are in VA facilities at Long Beach; Wood, Wis; Augusta, Ga; Bronx, NY; Brockton, Mass; Castle Point, NY; Cleveland; East Orange, NJ; Hampton, Va; Houston; Maywood, Ill; Memphis; Miami; Palo Alto, Calif; Richmond, Va; St Louis; San Juan, Puerto Rico; and West Roxbury, Mass. Additional centers are planned in Salt Lake City, San Diego, and Seattle.—P.G.

the Chicago system, says Meyer, "the acute care nursing staff has extensive experience in managing the unique problems of spinal cord patients, including the special management of bowel and bladder functions; the prevention and treatment of urinary tract infections, cardiorespiratory problems, abnormal BP, and other autonomic disturbances peculiar to the quadriplegic and paraplegic patient. The system is also familiar with the psychological disruption common in spinal cord injury patients and their families," he adds, "so a social worker is an integral part of the treatment team. Special meetings for the families are held twice a week and conducted by the social worker and a nurse clinician."

Surgery

Surgery rarely is done immediately unless the cord function, as determined by repeat neurological examinations and measurements of the somatosensory cortical evoked potential, continues to deteriorate.

Evoked potential involves electrical stimulation of areas of skin that normally are innervated from the 31 spinal cord segments. For example, a pulsed electrical signal (of a known duration and intensity) is applied to the foot, the knee, and other areas. If the signal gets through to the cerebral cortex, it is picked up via electrodes attached to the patient's skull. A computer sorts out background CNS electrical "noise" to help clinicians determine the extent (or absence) of damage to various spinal cord segments.

If, in the case of an incomplete lesion, an injury to the cervical spinal column cannot be managed through conservative methods (such as traction or positioning on a Stryker frame bed), or the vertebral displacement is unstable and occurs again after reduction, or the injury is likely to further damage the nerves, surgery may be needed to decompress the cord, says Meyer. Similarly, thoracolumbar surgery may be undertaken if bone or disk fragments are encroaching on the nerves or dura or if the spinal segments cannot be realigned and stabilized otherwise.

Neurosurgeons and orthopedic surgeons often team up for such procedures. The impinging fragments are removed and a piece of bone from the patient's hip may be inserted into the unstable area. Some research also is under way on prostheses.

Steel support rods usually are added in the case of thoracic or lumbar injuries to maintain alignment and add stability. A body cast also may be employed. For cervical injuries, an occipitomandibular immobilizer orthosis sometimes is used.

The posterior arch of one or more vertebrae may be excised occasionally when there is a tear in the lining of the cord. But decompression often is done now via a



Dr Paul R. Meyer, Jr

frontal approach (*JAMA* [MEDICAL NEWS] 1978; 239:1597-1598).

Rehabilitation

Once the patient's vital signs are stable, intensive rehabilitation efforts begin. In Chicago, this occurs at Northwestern Memorial Hospital and continues at the nearby Rehabilitation Institute of Chicago under the supervision of Terry V. Carle, MD, codirector of the Midwest system. The efforts include medical care, physical therapy, occupational therapy, sex reeducation, vocational counseling, financial counseling, and psychological services.

As the name implies, the Rehabilitation Services Administration's series of spinal cord injury care systems emphasize efforts to bring patients as much into the mainstream of life as possible. The family and "significant other" persons in the patient's life are included. At Rancho Los Amigos Hospital, for example, there is a "model home," converted from a schoolhouse on the grounds. The building also serves as a rehabilitation engineering demonstration unit for the National Institute of Handicapped Research, as does a building at Northwestern.

The model home allows paraplegic and even quadriplegic patients to work with therapists in learning self-care and performance of household chores in the unit's kitchen, living room, bedroom, bathroom, and classroom areas. The home is stocked with various devices that the patient can use to determine which fits his or her needs. These include mouthsticks that can be used for a number of tasks from dialing telephones to typewriting, lapboards for holding books or papers, and special controls for electrical devices.

Setbacks can occur. Spinal cord injury patients are
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cautioned about pressure necrosis, which can now often be prevented through use of equipment that enables the patient to change position and to avoid prolonged pressure on certain body areas. Maintenance of good skin condition, cleanliness, and regular daily inspection for pressure sores are important as well.

"Because of the special needs of these patients," say Rancho Los Amigos officials, "a program was designed to emphasize behavior modification, along with the appropriate medical and surgical attention to their pressure sores and orthopedic problems. . . . On entering the program, the patient signs a treatment contract that outlines the rules for participation."

Other complications include bladder infections and poor bowel control. These have been offset to some degree by patient education about intermittent catheterization every six to eight hours (thus avoiding some of the potential for infection of the permanent indwelling catheter) and through regular bowel elimination patterns achieved by a combination of diet, massage, and rectal stimulation techniques.

Research continues. Northwestern investigators have developed disposable, self-contained female and male catheterization kits that are widely used in this country and Canada.

In addition, as patients progress in their rehabilitation, other opportunities are available. A Handicapped Boaters Association recently has been chartered in New York State. There is also a National Wheelchair Athletic Association.

Prevention

Motor vehicle accidents account for one third to more than one half of spinal cord injuries treated each year.

Some universities and other research centers are investigating what happens to a spinal cord subjected to such trauma. In Washington, DC, the National Highway Traffic Safety Administration uses lifelike dummies in this research (*JAMA [MEDICAL NEWS]* 1978;239:187, 1980;243:1410). To prevent the injuries, continued enforcement of the 55 mph speed limit is being urged, as is restoration of requirements in all states that motorcyclists wear helmets and that passengers in motor vehicles and in light (private) airplanes wear seat and chest belts.

Falls are the next most common cause of spinal cord injuries, followed by assault (particularly gunshot wounds) and sports accidents. Water sports, notably diving, account for a high percentage of the injuries connected with athletics.

Several sports medicine groups are looking into this with an eye toward prevention. One early effort was that of the National Athletic Trainers Association

and the Center for Sports Medicine at Temple University School of Medicine, Philadelphia. They set up a national football head and neck injury registry (*JAMA [MEDICAL NEWS]* 1977;238:2469-2473). The Phoenix center also is getting involved in data gathering on sports injuries, says Meyer.

Still other causes of spinal cord injuries are falling or flying objects.

As part of the emphasis on prevention, the Midwest system is engaged in a public education campaign using "Mr Clunk," a cartoon creation (Figure). The hope is that "Mr Clunk" will be to hazardous acts causing spinal cord injuries what the cartoon character "Mr Yuk" has been to the poison control network's efforts to reduce accidental ingestion of poisonous substances.

Besides Chicago and Rancho Los Amigos, the other regional spinal cord injury care systems are located at the University of Washington, Seattle; the University of Alabama, Birmingham; New York University; the University of Virginia, Fishersville; Boston University; the University of Missouri, Columbia; the University of Miami; Texas Medical Center, Houston; Craig Hospital, Englewood, Colo; Santa Clara Valley Medical Center, San Jose, Calif; and Jefferson Medical College, Philadelphia.

And, finally, a new group may be swinging into action: the 12-member (five physicians including Meyer) President's Council on Spinal Cord Injury created by former President Jimmy Carter in one of his final acts before leaving office.—by PHIL GUNBY

