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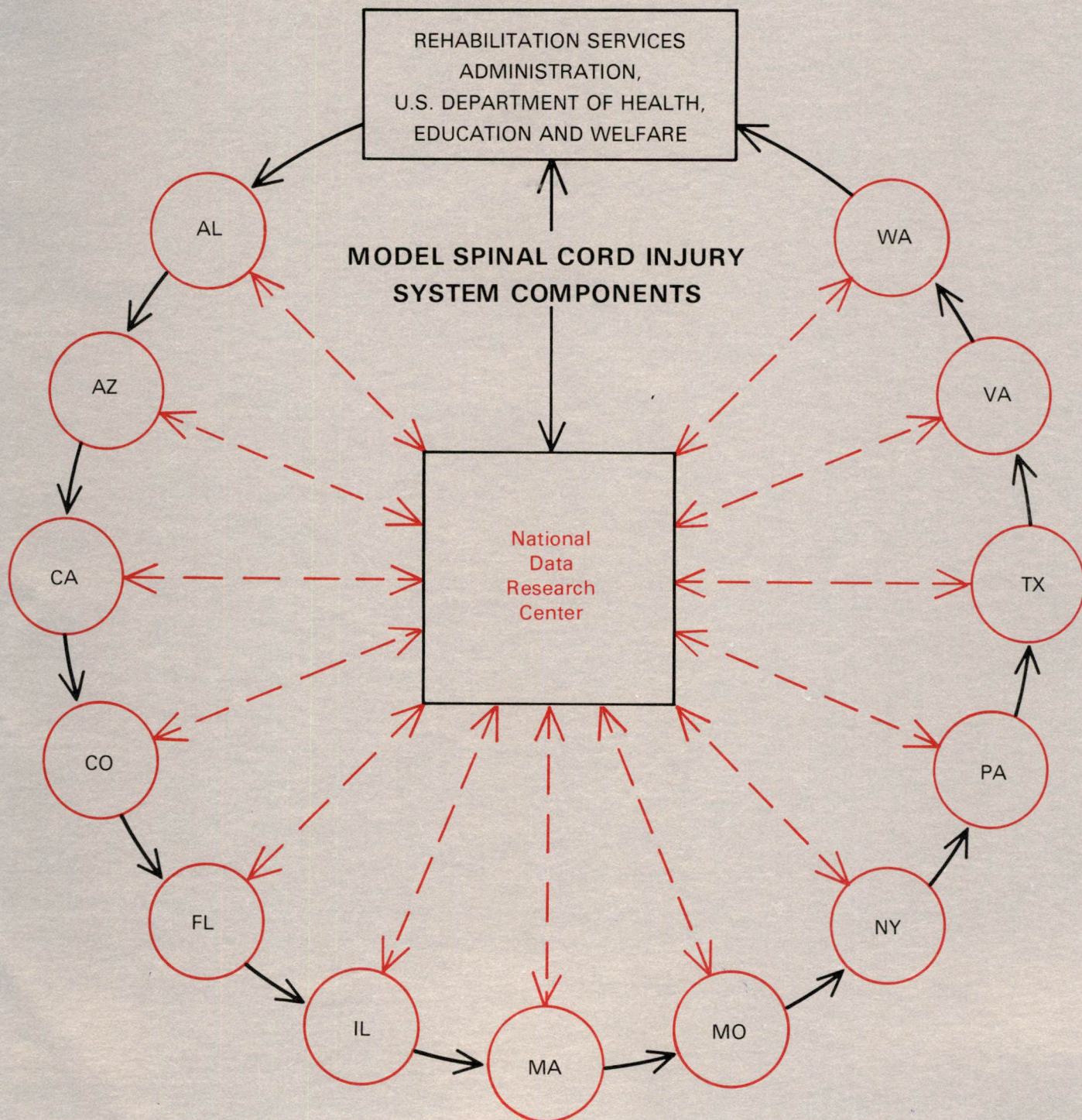
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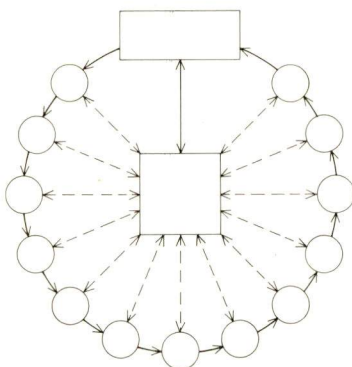
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SCI DIGEST





FRONT COVER: This schematic diagram is symbolic of the functional interrelationships between the Regional Model Spinal Cord Injury (SCI) Systems, the National SCI Data Research Center and the Rehabilitation Services Administration, U.S. Department of Health, Education and Welfare. Each circle represents an individual Regional SCI System with the appropriate State abbreviation within the circle showing the location of each.

SCI DIGEST

In This Issue . . .

From the Data Bank . . .

EDITORIAL. John S. Young	2
--------------------------------	---

Featured Guest

THE RUSSIAN EXPERIENCE. Robert R. Jackson	3
---	---

Featured Articles

A SYSTEM APPROACH TO EMS FOR SPINAL CORD INJURY VICTIMS.

Philip R. Fine, Samuel L. Stover, and Michael J. DeVivo	5
---	---

SPINAL CORD INJURY AND THE EMT

Philip R. Fine and Samuel L. Stover	8
---	---

ARIZONA EMERGENCY MEDICAL SYSTEM

John M. Vivian and Carolyn J. Mitchell	28
--	----

System Statistics

STATISTICAL INFORMATION PERTAINING TO SOME OF THE MOST COMMONLY ASKED QUESTIONS ABOUT SCI

— PART II. John S. Young and Nancy E. Northup	11
---	----

DATA BANK — CURRENT STATUS	36
----------------------------------	----

This-N-That

ASIA NOTE	22
-----------------	----

CORRECTION	24
------------------	----

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FROM THE DATA BANK . . .

THE NITTY-GRITTY OF DATA COLLECTION



John S. Young, M.D.

"Let's collect some data!" This laudatory proposition is a bit like saying "Let's get married!" Exciting revelations and the pursuit of happiness are envisioned with little heed given to future implications or consequences. We can contemplate the ecstasy now and deal with the agony later.

In 1970, the Southwest Regional System for Treatment of Spinal Injury (SWRS) was funded by the Rehabilitation Services Administration (RSA), U.S. Department of Health, Education and Welfare, to demonstrate a regional system of spinal cord injury (SCI) care. Among

the objectives of the program was the development of a data base to document the results achieved, particularly rehabilitation outcomes and cost effectiveness.

The original data base — long on fantasy and short on pragmatic realism — contained 472 variables designed to answer all of the clinical, psychological, social, vocational and economic questions of interest to the multiple professional disciplines involved in providing or paying for the services required by the spinal cord injured. The number of variables adopted for inclusion in the data base almost became a status symbol for each specialty. Medical social workers wanted social data. Vocational counselors needed vocational data. Physical and occupational therapists required functional data. Worst of all, orthopedists, neurosurgeons, psychiatrists, plastic surgeons, urologists, pulmonary physicians and other medical specialists were anxious to acquire statistical "results" of their clinical contributions.

Over the course of the first year, it became apparent that such a "shotgun" approach was counter productive. The volume of data required was uncollectable, unmanageable and quite meaningless when the variance indigenous to spinal cord injury was compounded by the relatively small number of cases represented in the data bank. The original 472 variables were then reduced to 108, sacrificing "completeness" for credibility.

As additional Regional Model SCI Systems were funded by RSA, a mechanism for pooling common data was obviously necessary to create a sample large enough to minimize the

(continued on page 34)

FEATURED GUEST

THE RUSSIAN EXPERIENCE

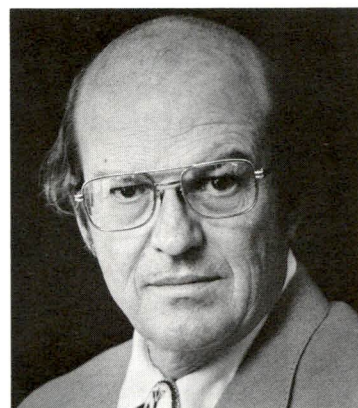
Robert R. Jackson*, MD
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Injury System

In recent years, several spinal cord injured American Citizens have journeyed to the Polenov Institute in Russia for reportedly "new" treatment of their injuries. All these visits were widely publicized by the news media in the United States. The great outcry in the media spilled over into demands from various groups that the Federal establishment as well as private agencies not only investigate this Russian phenomenon but also support the use of these reportedly "new" treatments for the spinal cord injured in the U.S.

The time has come to place this matter in perspective. The work reported by Dr. L.A. Martinian is admittedly an effort at extending the work begun in this country (U.S.A.) over 30 years ago. The original investigators were primarily Drs. L. W. Freeman, William F. Windle and William W. Chambers who reported on experimental work with animals. They noted that certain pyrogens and, later, certain enzymes seemed to influence the recovery of central nervous system function in what were otherwise spinal injured laboratory animals.

Dr. Martinian's work is summarized in English in the book, *Experimental Studies in Regeneration of Spinal Neurons* (V.H. Winston and Sons, 1977, Editor: Tat'yana Nesmeyanora). In essence, the claim is made that the trypsin experiments started by Dr. L. W. Freeman, University of Indiana, have been extended using various enzymes including hyaluronidase and lactase. Apparently, these endeavors were translated into an unknown number of human experiments by Dr. Veniamin Ugriumov, Director of the Leningrad Research Institute of Neurosurgery. He used not only the enzymes but also hyperbaric oxygen in his human experiments.

In June 1976, both Drs. Martinian and Ugriumov visited the United States in May and June at the invitation of the National Institute of Neurological and Communicative Diseases and Stroke



Robert R. Jackson, M.D.

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(NINCDS), National Institute of Health (NIH). The Russians did not offer any details of their work but rather spoke in broad terms about a general attitude and approach to therapy. The number of patients they'd treated was not given. (For a more detailed description of the treatment program in question, please see the article by Dr. E. Mannarino in the *Paraplegia News*, 32, p. 79, or *The Journal of the American Paraplegia Society*, II, March 1979.)

At this point, what would otherwise have been a little noticed clinical experiment became the subject of great interest and speculation as a result of extensive publicity by the lay press in the United States. Multiple endeavors by the Director of the Stroke and Trauma Program of NINCDS, by the Chairman of the Medical Advisory Committee of the National Spinal Cord Injury Foundation and by many other interested individuals, both inside and outside our government, failed to produce any results confirming those reported in the Russian literature. *No verifiable solid scientific evidence has been found to confirm that the course of human central nervous system trauma is altered by the reported treatments at the Polenov Institute in Leningrad.* Dr. Robert White's comments on his endeavors at the 1979 ASIA Meeting substantiates the lack of confirming evidence reported by other U.S. scientists.

Furthermore, under the auspices of NINCDS, Dr. Lloyd Guth and others attempted to repeat the Martinian experiments. (The results of these experiments were reported at the 1979 American Association of Neurological Surgeons in April.) Dr. Guth found that if he used the reported Martinian technique for sectioning the spinal cord of a rat that, indeed, a number of the animals apparently did achieve neurological recovery. However, when the animals were sacrificed, and the spinal cords examined, some intact anterior fibers were found. Apparently, these fibers were left intact by the sectioning technique used by Martinian. It has been known for years that if as little as five percent of the animal's cord is left intact, significant apparent neurological recovery can occur.

Dr. Guth then refined the sectioning technique to ensure complete severing of the spinal cord. In those animals, with complete sectioning of the cord, no neurological recovery occurred. Following these studies, U.S. investigators stated that *"the report of spinal recovery following transection was probably due to the incompleteness of the transection rather than to enzyme treatment."* Thus, serious doubt now exists about the validity of Dr. Martinian's findings and about their applicability to the treatment of spinal injury in humans.

Further efforts in this country and elsewhere to repeat the Martinian experiments led to the conclusion that — as reported by NINCDS — *"No evidence was found that enzyme treatment significantly reduced scar formation or affected restitution of sensation, posture or locomotion in spinal rats."*

Disregarding the failure of a number of qualified investigators to get hard facts from the Soviet Union and the inability of qualified research personnel to repeat the Martinian experiments, the rather provocative United States news stories have continued thus raising the expectations of a "cure" for many of the spinal injured. As a matter of fact, Messrs. Waldrep, Hurt, and Turcotte — three U.S. Citizens who visited the Soviet Union for treatment — have announced the formation of a new foundation to pursue further exploration of the Russian techniques. They are promoting the intrathecal enzyme combined with hyperbaric oxygen as a procedure for the treatment of spinal cord injured humans.

From interviews — both audio/visual and printed — with these three gentlemen and other U.S. Citizens who visited the Soviet Union, there is no question that the intensive and virtually one-on-one physical therapy program, which continues throughout the treatment day, does have a beneficial effect on existing musculature and the patient's general outlook on life. However, *all U.S. Citizens who received the "Russian" treatment remained paraplegic* — any "improvements" are clearly those attributable to intensive physiotherapy and psychological support.

(concluded on page 34)

A SYSTEMS APPROACH TO EMS FOR SPINAL CORD INJURY VICTIMS

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The eventual medical outcome for the spinal cord injured patient is dependent, in great part, on the handling the victim receives at the injury scene and the appropriateness of the emergency management. The spinal cord injured patient when initially examined is frequently found to have a number of unique problems with which emergency medical personnel must cope. Experience has shown that the likelihood of adverse consequences may be significantly reduced if a rapid but appropriate decision making procedure is followed.¹

The sequence of steps in decision-making may be shown in a flowchart format commonly referred to as an algorithm. Steps or junctures in a process of this nature are designated by a series of standard symbols frequently used by computer programmers.²

In the remainder of this article, the general Operational Algorithm currently being implemented by the Regional Model Spinal Cord Injury (SCI) System, located at the University of Alabama in Birmingham (UAB), will be described. Although certain processes or steps (particularly those pertaining to reporting or recordkeeping requirements) are unique to the UAB Center, the general scheme is suitable for numerous other applications.

The portion of the algorithm discussed herein is restricted to the Emergency Medical Service (EMS) component of an overall management/care system. Since the Regional Model SCI System is a functional unit of a larger general rehabilitation facility, the rehabilitation steps are not included, but they do exist and are available on request.

BACKGROUND

A major objective of the federally sponsored Regional Model Spinal Cord Injury Program is the development of an organized continuum or "system" of care for the spinal cord injured patient. For investigative purposes, satisfaction of very specific criteria determines whether the patient is considered "System," or "Nonsystem". Yet, when a patient is admitted to the Spinal Cord Injury Sys-

tem, regardless of research category classification, all activities and services are initiated and provided without further distinction; that is, all patients receive exactly the same medical and allied health services.

The current Operational Algorithm was included with the Fifth and Sixth Annual Reports of the UAB SCI System (a limited number of copies are available through the Center). The Algorithm or Systems flowchart is the product of considerable effort and activity expended in developing a suitable "front end" or Emergency Medical Service (EMS) component.

SEQUENCE OF DECISIONS AND RECOMMENDED PROCEDURES

The extreme left portion of the algorithm designates the point of trauma. After notification and arrival of appropriate EMS personnel, decisions regarding immediate disposition, care, and management of the patient must be made. It must be determined whether life support is required; whether immobilization of the patient is necessary; and, in the case of accidental events resulting in entrapment of the patient, whether special extrication procedures are needed. An affirmative determination at any decision point results in the provision of the particular service or requirement cited. Such a response is depicted as a Systems Loop.

During disposition and handling procedures, the patient must be continually monitored and reassessed for changes in life-support requirements. If, in fact, changes in life-support requirements are observed, they must be provided by EMS personnel.

At this point, the patient is more thoroughly evaluated for the possibility of spinal cord injury. If such an injury does not appear to exist, the patient is transported to the closest appropriate hospital or trauma center following radio notification by EMS personnel of patient evacuation and probable arrival time.

EMERGENCY MEDICAL FACILITY

If the patient is believed to have sustained a spinal cord injury, the distance from the accident site to the Regional Spinal Cord Injury Center is determined. If the accident site is more than 25 miles from a Regional SCI Center, the patient is transported to the nearest appropriate medical facility. Simultaneously, the Regional SCI Center is notified by radio of the patient's evacuation to that emergency medical facility.

On arrival at the emergency room, the patient's medical status is further evaluated, and the preliminary spinal cord injury diagnosis is reassessed. A medical decision as to the stability of the patient's general medical condition is then made. If the patient's condition is stable, and appropriate immobilization of the spine is confirmed, the Regional SCI Center is so notified. The patient is then transferred to the Regional SCI Center without being admitted to the local hospital.

If the patient's medical condition is unstable and additional emergency medical attention is required, the attending physicians then become responsible for making appropriate arrangements for medical and/or surgical care. This will most likely require a short term admission of the patient to the local hospital.

REGIONAL SCI CENTER CARE

If the accident site is 25 miles or less from the Regional SCI Center, the patient is evacuated, in most instances, directly to the Center bypassing other hospitals. Hospital "drive-by" may be forgone if:

- The patient's condition deteriorates enroute to the SCI Center.
- Local transfer agreements and evacuation protocols require local hospital evaluation.

Nonetheless, after admission to the Regional SCI Center/Acute Care Area, no further distinction is made between patients whose trauma sites were more or less than 25 miles from the Center.

Following admission to the Acute Care Area of the Regional SCI Center, appropriate medical and data collection activities are initiated. For example, upon admission to the University of Alabama in Birmingham Hospital through the Emergency Department, standing orders exist which result in immediate notification of the following services: Neurosurgery, Urology, Orthopedics, Trauma, and Rehabilitation Medicine. The primary admitting service very likely will be Neurosurgery. However, by virtue of the University Cooperative Agreement, all services identified above participate from the onset in patient care activities.

The SCI Registry is queried to determine whether early notification of the particular patient's injury, as called for in the algorithm, occurred, and if not, the Registry is notified accordingly.

At this point, provision of acute medical care is continued until the patient is ready for transfer to the rehabilitation facility.

SUMMARY

Recapping the Operational Algorithm and the team which serves the needs of the spinal cord injured patient: the numerous disciplines represented by a variety of health professionals assume roles and responsibilities of equal importance. Fundamental to an approach of this nature is coordination of individual activities coupled with an appreciation and understanding of the professional roles of other participating disciplines.

It is apparent that the logistical requirements of a spinal cord injured patient are seriously beyond the practical capacity of any single discipline or individual. For this reason, we are strong advocates of the multidisciplinary team approach to their care.

The algorithm depicts, of course, the "ideal" management sequence. It is readily admitted that real time modification is often necessary because the most complex variable, the patient, frequently has special requirements which must be met on a practical basis. In fact, an inherent strength of the system lies in its ability to be responsive to the special needs presented by each individual patient.

It would be unrealistic to suggest that this model will be suitable for application in every spinal cord injury care setting. Yet the fundamental structure, in its current state of refinement, is most assuredly valid. During the coming year, further refinement of the operational system is anticipated along with improved efficiency in the delivery of multidisciplinary care to the patient who has suffered spinal cord trauma.

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SPINAL CORD INJURY AND THE EMT

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INTRODUCTION

The disparity between the actual and the ideal delivery of medical care is probably most marked in the handling of patients with spinal cord injury. In few other areas of medicine does the lag between technical knowledge about a disorder and its actual implementation seem as great. National and International experience indicates that patients with acute spinal cord injuries are best managed at comprehensive health care centers specially equipped to provide a multidisciplinary team approach to patient care.¹ Yet, the most sophisticated spinal cord injury center can do no better than the Emergency Medical Service (EMS) component responsible for the immediate post-injury extrication, immobilization, stabilization and evacuation of the injured person.

The Emergency Medical System is the organized entity which deals, initially, with the spinal cord injury victim. The Emergency Medical Technician (EMT), who is at the forefront of patient care activities immediately after the accident, assumes an important role in determining the eventual outcome of the patient's care and treatment.

EMS AND THE SPINAL CORD INJURED

A well organized system of care for spinal cord injured patients consists of two separate and distinct components. The first component involves patient care activities from the time of injury until admission to a specialized spinal cord injury center. The second, concerns patient care activities subsequent to admission to the specialized medical facility. The injury, its characteristics, prognosis and basic emergency management procedures will be examined.

HOW THE INJURY NORMALLY OCCURS

Injuries resulting in quadriplegia or paraplegia are usually secondary to direct spinal cord trauma and may result from a fracture or dislocation of the surrounding vertebral elements or from penetrating missiles such as bullets or knife wounds. The characteristics of the bony injury to the spinal

column and the neurological injury to the spinal cord and nerve roots must be considered individually and in detail to accurately assess the extent of trauma, select the proper emergency treatment and, thus, increase the likelihood of accurately predicting the patient's eventual physical condition.

NEUROLOGICAL INJURY

The neurologic injury to the spinal cord must be differentiated from the neurologic injury of the nerve roots. Spinal cord injuries which are complete (total motor and sensory loss) for twenty-four (24) hours are unlikely to have good functional recovery. Nerve roots which are injured in or about the area of trauma (even with complete cord injuries) may recover.

Spinal cord injury in the cervical area is incomplete if any sensory or voluntary motor function remains below the level of the cervical cord injury. In the lumbar and sacral areas, the injury is incomplete if there is sacral sparing. Spinal shock may affect the spinal cord a segment or two above the level of actual cord injury. Therefore, with time and disappearance of the spinal shock, some return of function and sensation may occur in the myotome or dermatome at the level of injury.

ETIOLOGY

Motor vehicle accidents are the leading cause of spinal cord injury followed by either gunshot wounds or diving accidents.^{2,3,4} Other water sports, stabbings, falls, and industrial accidents account for the vast majority of all remaining injuries. Statistics from spinal cord injury centers throughout the United States indicate that three to four times more males suffer spinal cord injury than females.^{2,3,5} The average age group is the mid-to-late twenties with the great bulk of the accidents involving persons between 15 and 40 years of age.

ASSOCIATED INJURIES

Associated injuries sustained by the patient at the time of spinal cord injury may be totally missed due to loss of muscle control and lack of sensation.⁶ The long bones of the extremities must be checked carefully for fractures and appropriate treatment initiated if the patient is to be able to manipulate a wheelchair or walk with crutches and braces in the future. Joint dislocations, which may totally disable a person, even if his spinal cord injury proves to be transient, may be easily overlooked and should always be considered. Intra-abdominal bleeding may be occult (due to the loss of sensation) and must be carefully evaluated. Intra-thoracic injuries, such as rupture of the diaphragm, fractures of the ribs, pneumothorax, hemothorax or hemopneumothorax may be masked by decreased tidal volume in the quadriplegic patient whose intercostal muscles have been paralyzed.

Associated injuries frequently delay prompt transfer of the victim from the first hospital to a specialized spinal cord injury (SCI) unit. After initial resuscitation and/or stabilization, however, the transfer should not be delayed further if a bed is available in a SCI unit. In fact, it is advisable to require that the patient be transported to the closest designated medical care facility, rather than to one that may be physically closer to the accident site but is not equipped to provide appropriate acute spinal cord injury care. Past experience has shown that the long term prognosis for the spinal cord injured patient is improved if the early acute care is in keeping with accepted standards.⁶ Evidence suggests that simply "*getting the patient to any nearby hospital*" is, ultimately, not in the best interest of the patient, unless there is an immediate life threatening situation, such as uncontrolled bleeding or respiratory shutdown, either of which would preclude transfer to a designated trauma center.

TRANSPORTATION — ROAD ACCIDENTS

Proper management of a spinal injured patient at the place of injury such as at the site of a traffic accident, before transportation to an acute care hospital, is extremely important. A fracture of the spine is usually evident to the first trained medical observer who arrives at the scene. Bystanders must be instructed to leave the patient in the position in which he is found and to make no attempt to place the victim in a more comfortable position. Emergency Medical personnel must be trained to immediately identify a possible spinal fracture, by asking the patient to specify the site of his pain and to move his extremities. If a spinal fracture is suspected, with or without neurological injury, a road accident victim must not be moved until appropriate stretchers are available. The victim should then be carefully moved while maintaining the position of deformity — picked up by at least three persons as a log and placed on an appropriate stretcher. The spine should be immobilized with special spine splints or with sandbags properly placed about the neck and/or the trunk. Other associated injuries of the extremities should be splinted in the position in which the patient is lying.

WATER SPORTS

Patients who suffer paralysis after diving, or while engaged in other water-sport activities, should be gently pulled from the water. If possible, the cervical spine should be maintained in a neutral position. If the patient shows evidence of drowning, turn the victim completely on his side, while carefully supporting his head, with his hips higher than his shoulders to help drain the water from the lungs. The victim should not be placed in a prone position, and the neck should not be twisted to one side. Of course, if the patient is in respiratory distress due to drowning, mouth-to-mouth resuscitation to restore breathing takes precedence but the spine should be very carefully extended, with simultaneous traction applied to the tongue to open the airway.

GUNSHOT WOUNDS

Gunshot wounds usually do not result in instability of the spine. These patients can be placed on a regular litter or stretcher and may be loaded into the ambulance in a supine position. Many gunshot victims may have associated injuries which will require other emergency medical procedures.

PREVENTING AGGRAVATION OF THE INJURY

During the first few hours following an injury to the spine, an incomplete spinal cord injury may progress to a complete spinal cord injury. This may be caused by one of three factors:

- Progressive swelling and edema of the cord causing interruption of neural transmission.
- Pressure on the vascular supply causing gradual ischemia of the spinal cord area.
- Aggravated trauma from rough and/or improper handling.

Approximately 10 percent of all patients have injuries which became worse during the first day. Spinal cord injured patients must be handled very carefully to ensure that further neurological damage is not due to traumatic handling. If neurological function impairment is due to edema only, functional recovery is possible. But, if the impairment is attributable to vascular embarrassment by venous congestion and gradual infraction, the condition is probably not reversible.

(concluded on page 33)

SYSTEM STATISTICS

STATISTICAL INFORMATION PERTAINING TO SOME OF THE MOST COMMONLY ASKED QUESTIONS ABOUT SCI

John S. Young, MD,
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Frequent requests for statistical information, pertaining to spinal cord injury, are received by the National SCI Data Research Center from government and private program planners, insurance companies, lawyers and other interested groups. The Model SCI Systems also report a large number of such requests from sources within their regions. Some of the information sought is available in the literature; some of the requested data is stored in the National Data Bank but is unpublished and, thus, is not usually available to nonsystem agencies; and some of the information is just not available from any one source — published or otherwise.

In order to standardize the response to such inquiries and ensure consistency in handling information requests throughout the Model SCI System, "statistical answers" to some of the more common questions were developed by the National SCI Data Research Center. These are presented herein to provide a *ready reference source* of information for dissemination to interested parties. Because of the volume of statistical information involved, the questions were divided into two parts. The first part was included in the Inaugural Issue, Spring — 1979, of the *Model Systems' SCI Digest*; the second part in the Summer — 1979 Issue. As additional data is accumulated, the published statistical information will be updated.

The Inaugural Issue (Spring — 1979) of the *SCI Digest* presented demographical and other information pertaining to the spinal cord injured population such as: the causes of injury; information about the duration of the hospitalization and rehabilitation period; and the costs associated with that phase of spinal cord injured care. The Summer Issue of the *SCI Digest* provides outcome information such as: utilization of ongoing services; the cost of these services; social and vocational achievements; life expectancy; and other information pertinent to the life style maintained by the individual following spinal cord injury.

Thereafter, a section in each issue of the *Model Systems' SCI Digest* will be devoted to the publication of timely statistical information. Once this information is published in the *Model Systems' SCI Digest*, it is protected by copyright and is available for unrestricted dissemination to all interested parties such as local, state, and Federal agencies, insurance companies and other organizations.

PART II: UTILIZATION OF ONGOING SERVICES, COST OF THESE SERVICES, SOCIAL AND VOCATIONAL ACHIEVEMENTS, LIFE EXPECTANCY, AND OTHER INFORMATION PERTINENT TO THE SCI LIFESTYLE.

The data presented in this section is limited to that reported by the Regional Model SCI Systems to the National SCI Data Research Center since 1973. Only traumatic spinal cord injury cases are included in the National Data Bank. No attempt was made to sample this group of cases. Therefore, the data reported herein are representative of the Model Systems' experience but are not necessarily valid for the traumatic spinal cord injured population of the nation.

Cases were selected from the Data Bank for which data had been reported in all three years following the anniversary date of injury. Distribution of these cases by follow-up years and calendar years is presented in Table 1. The largest group was injured in 1975 (80%). Therefore, the first anniversary year following injury for this group was 1976.

Obviously, the study group reported herein is not identical to that of Part I which was reported in the first issue of *Model Systems' SCI Digest*. However, the follow-up group is similar with respect to age at injury; sex; as well as, extent and level of neurological impairment. All data reported herein is in the NSCIDRC Data Bank as of July 1979.

Tables showing dollar values include only those cases for which actual amounts were reported. They are not estimates. If no expenses were incurred in a category for an individual case, the dollar value was recorded as "zero". Dollar values were not corrected for inflation.

The data covers the first three years following injury which are probably the most crucial in terms of adapting to life as a spinal cord injured individual. As additional information is collected for subsequent years, these data will be up-dated. The experience of the first three years should not be considered representative of the remaining life expectancy of the injured person.

The Year One follow-up period is that portion of the year remaining after the initial medical and rehabilitation (injury-to-home) period. Since the time span for this period varies considerably, due to the extent and level of neurological impairment and other factors, the balance of the Year One data presented in this report, will be affected by this time variation.

Table 1. DISTRIBUTION OF REPORTED CASES BY FOLLOW-UP YEAR AND CALENDAR YEAR (N=549)

Calendar Year	Number of Cases Reported in Follow-up Years		
	Year 1	Year 2	Year 3
	N	N	N
1974	1	0	0
1975	41	1	0
1976	439	41	1
1977	68	439	41
1978	0	68	439
1979	0	0	68

July 1979

Q1. What is the life expectancy following spinal cord injury?

Recent statistics, submitted for publication by DeVivo, Fine, Maetz and Stover (University of Alabama in Birmingham Spinal Cord Injury System) established an average life expectancy (ALE) of 30.2 years for spinal cord injury victims. However, the concept of average life expectancy must be approached with caution and kept in proper perspective. Estimates of life expectancy for a specific individual must be qualified by a number of factors. Among the most important of these are: age at time of injury, sex, neurological level, and completeness (extent) of lesion.

For example, using the tables developed by DeVivo et al, (based on the previous work of Jousse, Wynne-Jones and Breithaupt) the estimated life expectancy (in years) — qualified by level and extent of lesion — for a twenty year old spinal cord injured male is as follows:

POPULATION	Aver. Life Expectancy (years)
General	49.7
Incomplete Paraplegia	47.9
Complete Paraplegia	33.7
Incomplete Quadriplegia	40.9
Complete Quadriplegia	21.6

The effects of the level and extent of the lesion on life expectancy has also been identified by other authors:

- Geisler, W. O., Jousse, A. T. and Wayne-Jones, M., Survival in traumatic transverse myelitis, *Paraplegia*, 14; 262-275, 1977.
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- Smart, C. N., and Sanders, C. R., *The Cost of Motor Vehicle Related Spinal Cord Injuries*. Washington, D.C.: Insurance Institute for Highway Safety, 1976.

Life expectancy following spinal cord injury will be the subject of a feature article in a subsequent issue of the *SCI Digest*.

Q2. What is the change in marital status following injury?

Following the onset of injury, apparently little change occurs in the marital status of these individuals (see Table 2). The high percentage of people who are single on onset reflects the large number of young people suffering from spinal cord injury.

**Table 2. MARITAL STATUS: PRE- AND POST-INJURY
(N=414)**

Marital Status	Marital Status: Pre- and Post-Injury							
	Pre-Injury		Post-Injury					
	At Onset		Year 1		Year 2		Year 3	
	N	%	N	%	N	%	N	%
Single	218	53	216	52	209	51	208	50
Married	136	33	129	31	129	31	121	29
Divorced	37	9	41	10	49	12	63	15
Separated	19	5	23	6	21	5	17	4
Widowed	4	1	5	1	6	1	5	1

July 1979

Q3. What is the living situation pre-and-post injury?

The large number of spinal injured individuals who are living with their families, friends, or alone, following an injury is an exceptional achievement for the injured and those involved in their initial care and training (see Table 3). At the end of the first year following injury, 90 percent were living in these situations. In addition, the "other" category in Table 3 includes many desirable types of living situations, such as fraternity houses, dormitories, halfway houses, and other similar living arrangements. By Year Three, the percentage of those living alone or with friends is about the same as the pre-injury level.

**Table 3. LIVING WITH WHOM: PRE- AND POST-INJURY
(N=412)**

Living With Whom	Living Situation: Pre- and Post-Injury									
	Pre-Injury		Post-Injury							
	At Onset		At Discharge		Year 1		Year 2		Year 3	
	N	%	N	%	N	%	N	%	N	%
Family	329	80	356	86	331	80	303	74	292	71
Friend	32	8	19	5	24	6	27	7	26	6
Alone	35	9	13	3	18	4	36	9	45	11
Institution	2	1	12	3	28	7	29	7	29	7
Other	11	3	11	3	11	3	17	4	20	5
Missing	3	1	1	0.2	0	0	0	0	0	0

July 1979

Perhaps the most important revelation of these data (see Table 4) is the fact that only three percent were discharged to nursing homes. Furthermore, the percentage of cases in this category remained stable for years two and three following injury. Only a few years ago, spinal cord injury conjured up the spectre of hopelessly disabled people existing in nursing homes. Obviously, this is inconsistent with the experience of the Model Systems.

**Table 4. PLACE OF RESIDENCE: PRE- AND POST-INJURY
(N=418)**

Residence Classification	Living Situation: Pre- and Post-Injury									
	Pre-Injury		Post-Injury							
	At Onset		At discharge		Year 1		Year 2		Year 3	
	N	%	N	%	N	%	N	%	N	%
Private Residence	409	98	400	96	383	92	379	91	383	92
Hospital	1	0.2	0	0	9	2	5	1	2	1
Nursing Home	0	0	13	3	15	4	16	4	17	4
Other	7	2	4	1	11	3	18	4	16	4
Missing	1	0.2	1	0.2	0	0	0	0	0	0

July 1979

Q4. How much assistance do paraplegics and quadriplegics require?

As would be expected, quadriplegics require much more assistance from others than paraplegics. Further, the need for assistance by paraplegics diminishes over time probably as the result of training, practice and attitudinal adjustment. Quadriplegics, however, required about the same amount of assistance in both the first and second year following injury. Apparently, somewhat less assistance is needed by quadriplegics during the third year (see Tables 5 & 6).

**Table 5. ASSISTANCE REQUIRED PER DAY BY NEUROLOGICAL CATEGORY IN YEARS FOLLOWING INJURY
(N=320)**

Neurological Impairment	Follow-up Year*	Number Cases	Assistance Required/Day		
			Mean	Std. Dev.	Median
		N	hrs	hrs	hrs
Paraplegics	Bal. yr. 1	162	1.7	4.4	0.3
	Year 2		1.2	3.2	.2
	Year 3		0.7	1.8	.2
Quadriplegics	Bal. yr. 1	158	5.6	7.1	3.3
	Year 2		5.3	7.1	2.9
	Year 3		4.0	5.6	2.2

* Anniversary of injury

July 1979

A large number of paraplegics get along without any assistance (see Table 6). By the end of the third year, almost three-fourths (74%) of the paraplegics are completely independent while the number of quadriplegics who require no assistance remains relatively constant over the three-year period (29, 28, and 30%, respectively). The number of quadriplegics requiring 24-hour care does appear to drop in the third year.

Table 6. MAXIMUM AND MINIMUM HOURS (EXTREMES) OF ASSISTANCE REQUIRED PER DAY AS A PERCENTAGE OF THE NEUROLOGICAL CATEGORY (Total Cases=320)

Neurological Category	Follow-up Years*	Number of Cases	Assistance Extremes**	
			None	24 hours
		N	%	%
Paraplegics	Bal. yr. 1	162	64	3
	Year 2		67	1
	Year 3		73	1
Quadriplegics	Bal. yr. 1	158	29	10
	Year 2		28	10
	Year 3		30	5

* Anniversary Year of Injury

July 1979

** Percentage of Neurological category

Q5. How many paraplegics and quadriplegics return to work within three years?

The literature is confusing with regard to post-injury employment of the spinal cord injured primarily because of definitional problems. We do not have standardized definitions, therefore, comparisons among various reports are difficult to make. For the purpose of this study, "working" is defined as employment in the competitive labor market. A broader category should be "vocational mode" which would combine working, homemaker and student into one category.

In Table 7, the pre-and-post injury occupational status of 413 cases is shown. By the end of the third year, 20 percent of all cases were working. This is an outstanding accomplishment considering the devastating consequences of spinal cord injury. Unfortunately, this achievement does not appear remarkable to the unrealistic prognostications that have crept into the literature.

By combining "working," "homemaker" and "students" into a category of "vocational mode," 49 percent of the cases were positively occupied at the end of Year Three. In the opinion of many experts, the spinal cord injured person does not achieve maximum ad-

Table 7. OCCUPATIONAL STATUS: PRE- AND POST-INJURY ALL CASES (N=413)

Occupational Status	Occupational Status: Pre- and Post-Injury							
	Pre-Injury		Post-Injury					
	At Onset		Year 1		Year 2		Year 3	
	N	%	N	%	N	%	N	%
Working*	247	60	48	12	53	13	84	20
Homemaker	8	2	9	2	12	3	14	3
Student	103	25	101	25	121	29	106	26
Retired	8	2	16	4	18	4	14	3
Unemployed	44	11	236	57	205	50	194	47
Other	3	1	3	1	4	1	1	0.2

* Includes not more than three in on-the-job training and sheltered workshop employment in any one year.

July 1979

justment to their injury for several years. In all probability, the occupational status will continue to improve following the third year. However, this remains to be verified by subsequent data.

Data not included in this study indicates that those individuals who return to work early are generally employed by the same employer and/or in a position similar to their pre-injury job. Of the 48 cases working at the end of Year One (Table 7), 73 percent returned to the pre-injury employer and 55 percent to a similar position. In subsequent years, a trend to employment by different employers and in different jobs was noted. In Year Two, those returning to the same employer was 53 percent and to a similar position 23 percent. The figures for Year Three are 40 percent and 23 percent, respectively.

Unquestionably, an individual's employment capability is influenced by the level and extent of the spinal cord injury. This is shown in Table 8. Paraplegics do better than quadriplegics and incomplete lesions do better in both categories.

Table 8. POST-INJURY EMPLOYMENT BY NEUROLOGICAL CATEGORY AND ANNIVERSARY YEAR OF INJURY
(Percent of all cases working by year)

Neurological Category	Post-Injury Employment: Anniversary Year of Injury					
	Year 1		Year 2		Year 3	
	N	%	N	%	N	%
Paraplegic						
Incomplete	88	14	83	17	75	27
Complete	155	16	147	15	134	22
Quadriplegic						
Incomplete	129	14	133	17	117	18
Complete	127	6	121	4	98	10
All Cases	499	12	484	13	425	19

July 1979

Table 9. POST-INJURY OCCUPATIONAL STATUS OF THOSE EMPLOYED AT INJURY
(N=247)

Post-Injury Occupational Status	Occupational Status: Anniversary Year of Injury					
	Year 1		Year 2		Year 3	
	N	%	N	%	N	%
Working	40	16	42	17	63	26
Homemaker	5	2	8	3	7	3
Student	26	11	42	17	36	15
Retired	8	3	10	4	8	3
Unemployed	166	67	144	58	133	54
Other	2	1	1	0.4	0	0

July 1979

Of particular interest are the persons who were employed at time of injury (Table 9). They should be logical candidates for employment following injury. In truth, 83 percent of those working at end of Year One were in this group. Twenty-six percent of this group were working by the end of Year Three — 75 percent of all those working at that time. An additional 15 percent remain in the student group, representing a potential for increased employment in the future.

Table 10. POST-INJURY OCCUPATIONAL STATUS OF STUDENTS AT INJURY (N=103)

Post-Injury Occupational Status	Occupational Status: Anniversary Year of Injury					
	Year 1		Year 2		Year 3	
	N	%	N	%	N	%
Working	6	6	6	6	15	15
Homemaker	0	0	0	0	2	2
Student	68	66	72	70	65	63
Retired	0	0	0	0	0	0
Unemployed	29	28	24	23	21	20
Other	0	0	1	1	0	0

July 1979

Table 10 indicates the post-injury occupational status of the group of young people who were students at the time of injury. A high percentage of these were able to continue as students post injury — 66 percent in Year One, 70 percent in Year Two and 63 percent in Year Three. Furthermore, by Year Three, 15 percent were employed. In other words, 78 percent of the student group at injury remain in a positive "vocational mode" at the end of Year Three.

Q6. To what extent does Neurological impairment change from system admission through the third year post-injury?

The data in Table 11 documents that little change occurred among the various neuro-impairment categories, following admission to the reporting Model SCI Systems and throughout the three post-injury years. The average time from onset to System admission for the reported cases was 36 days. Twenty seven percent of all reported cases were admitted within 24 hours.

Table 11. CHANGE IN NEUROLOGICAL IMPAIRMENT CATEGORY FROM SYSTEM ADMISSION THROUGH FOLLOW-UP YEAR THREE (N=454)

Neurological Impairment	Neurological Change Through Year Three							
	System Admission		Year 1		Year 2		Year 3	
	N	%	N	%	N	%	N	%
Paraplegic								
Incomplete	62	14	75	17	77	17	78	17
Complete	152	34	142	31	139	31	141	31
All	214	48	217	48	216	48	219	48
Quadriplegic								
Incomplete	114	25	120	26	124	27	127	28
Complete	126	28	117	26	114	25	108	24
All	240	53	237	52	238	52	235	52

July 1979

Q7. How does the number of days hospitalized following injury vary among neurological categories?

Total days hospitalized following injury is shown in Table 12 (page 20). Known values were available for 384 cases in all three years. The first-year values combine the days spent in the hospital during the initial hospitalization and rehabilitation (injury-to-home) period plus the remainder of the first post-injury year. Complete and incomplete paraplegics as well as incomplete quadriplegics experienced about the same number of hospital days. Complete quadriplegics, however, required almost twice as many. The same trend continues during the second and third post-injury years. Of particular note, however, is the reduction in days in the third year. Additional follow-up data will be necessary to determine to what extent this pattern is valid. The total days hospitalized during the first year in this study is considerably lower than that reported by Webb et al.* Their reported average length of stay was 248 days for all quadriplegics and 189 days for all paraplegics.

Q8. What is the breakdown of average total days hospitalized over the three-year period following injury?

The breakdown of cases into groups, according to their pattern of re-hospitalization, is shown in Table 13. These are mutually exclusive groups. The shortest injury-to-home period (130 days) was experienced by the group re-hospitalized only in the balance of the first year. Of interest is the observation that the total days hospitalized by this group is approximately the same as the group with no re-hospitalization. At the other end of the spectrum is the group that was re-hospitalized in both the second and third years. This group had a total three-year hospitalization experience of 277 days. This is comparable with the group hospitalized in all three years.

Table 13. BREAKDOWN OF AVERAGE TOTAL DAYS HOSPITALIZED DURING THE THREE-YEAR PERIOD FOLLOWING INJURY
*(Total N=384)

Follow-Up Years Hospitalized	Average Total Days Hospitalized							
	Number of Cases	Percent of Total*	Injury to Home	Balance of Year 1	Total Year 1	Year 2	Year 3	Total All Years
	No.	%	x	x	x	x	x	x
No Years	100	26	158	0	158	0	0	158
One Year Only	132	34						
Year 1	46	12	130	22	152	0	0	152
Year 2	52	13	179	0	179	27	0	206
Year 3	34	9	159	0	159	0	19	178
Two Years	101	26						
Years 1 & 2	44	11	145	28	173	25	0	198
Years 1 & 3	11	3	165	59	224	0	24	248
Years 2 & 3	46	12	207	0	207	44	26	277
All Three Years	51	13	155	38	193	38	42	273

July 1979

*Webb, Samuel B., et al. First year hospitalization costs for the spinal cord injured patient. *Paraplegia* 15: 311-318, 1977-78.

**Table 12. DAYS HOSPITALIZED FROM INJURY THROUGH FOLLOW-UP YEAR THREE FOR ALL CASES
(N=384)**

	Days Hospitalized												
Neurological Category	Injury-to-Home			Balance Year 1		Total Year 1		Year 2			Year 3		
	N	$\bar{x}$	SD	$\bar{x}$	SD	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Paraplegics													
Incomplete	64	128	47	9	25	137	54	65	12	28	62	8	23
Complete	122	144	67	12	26	156	74	120	15	34	122	11	33
All	186	138	61	11	25	149	68	185	14	32	184	10	30
Quadriplegics													
Incomplete	97	169	71	9	21	178	74	99	14	28	100	8	21
Complete	100	198	63	19	62	217	78	99	26	37	92	17	34
All	197	184	68	14	46	198	79	198	20	34	192	12	28
All Cases*	384	162	69	13	38	174	78	384	17	33	384	11	29

*Includes 8 cases for which the number of days hospitalized was known but the category of neurological impairment was unknown

July 1979

Q.9 *What is the pattern of hospital utilization following initial discharge?*

The pattern of hospital utilization following initial discharge is presented in Table 14. In general, incomplete lesions — both paraplegics and quadriplegics — fare better than their complete counterparts. A third of the incomplete paraplegics escape re-hospitalization during the entire three year period. Only 15 percent of the complete quadriplegics did as well. Interestingly, all of the neurological categories experienced approximately the same percentage of cases re-hospitalized in all of the three years.

**Table 14. HOSPITAL UTILIZATION IN FOLLOW-UP YEARS ONE THROUGH THREE
(N=384)**

Neurological Category	Hospital Utilization								
	Hospitalized 0 of 3 Years		Hospitalized 1 of 3 Years		Hospitalized 2 of 3 Years		Hospitalized 3 of 3 Years		Total All Years
	N	%	N	%	N	%	N	%	N
Paraplegic									
Incomplete	21	33	27	42	11	17	5	8	64
Complete	29	24	48	39	29	24	16	13	122
Total	50	27	75	40	40	22	21	11	186
Quadriplegic									
Incomplete	34	35	34	35	18	18	12	12	98
Complete	15	15	23	23	43	43	18	18	99
Total	49	25	57	29	61	31	30	15	197
Total	100*	26	132	34	101	26	51	13	384*

*Includes one case with unreported neurological category

July 1979

The number of hospital admissions per patient, following initial discharge, is indicated in Table 15. An important observation is the high percentage of people who are not hospitalized in any one time period — 60 percent in the balance of the first year, 49 percent in the second and 61 percent in the third. Equally interesting, is the increase in persons **not** hospitalized in Year Three as compared to Year Two.

**Table 15. NUMBER OF HOSPITAL ADMISSIONS PER PATIENT PER YEAR
FOLLOWING INITIAL DISCHARGE
(N=400)**

Hospital Admissions	Admissions Following Initial Discharge					
	Balance Year 1		Year 2		Year 3	
	N	%	N	%	N	%
None	238	60	196	49	244	61
One	113	28	108	27	93	23
Two	34	9	54	14	42	11
Three	7	2	19	5	10	3
Four	4	1	13	3	5	1
Five	3	0.8	2	0.5	1	0.3
Six	1	0.3	5	1	4	1
Seven			2	0.5	1	0.3
Eight			1	0.3		

July 1979

Q10. What are the expenses incurred by the spinal cord injured in the years following onset of injury?

The total expenses incurred during the first year following injury are broken down by category in Table 16 (page 23). The table is confusing in that the dollar values and standard deviations represent the average of all cases for which data were available for each expense category in that time period. For example, in the injury-to-home period, known values for hospitalization were available for 374 cases with an average of \$28,882. For the Year One follow-up period, 437 cases with known hospitalization values had a mean of \$1,579. The 333 cases reported in the "total" column, Table 16, were those with reported known values for both the injury-to-home period and the follow-up Year One. This group averaged \$30,481 for hospitalization in Year One which is close, but not identical, to the sum of \$28,882 plus \$1,579 (\$30,461) reported in the previous columns.

The actual dollar amounts given in Table 16 have not been corrected for inflation. The population on which the data was collected represents cases receiving services in 1975 thru 1977 with the bulk of them injured in 1975. Expense data in this current report will be converted to a base year and reported in a subsequent issue of the *SCI Digest*.

The reader is reminded that these data represent average values and include a sizeable number of cases with "zero" expenses in most categories. This, combined with extremely high values reported for a few cases in some categories, contributes to the large standard deviations noted in Table 16. For example, expenses for environmental modification averaged \$2,786 for the first year. But, 204 of the 307 cases (66%) had "zero" expense in this category while ten cases had expenses in excess of \$20,000. In a like manner, 363 cases had "zero" attendant care (82%) expense. However, three cases exceeded \$10,000 for attendant care. Their expenses were \$12,523, \$15,236, \$26,005, respectively. Only ten cases reported custodial care costs averaging \$4,738 each.

Only 44 cases incurred expenses for vocational rehabilitation. It must be pointed out that these expenses represent vocational rehabilitation services purchased by an agency such as the State Vocational Rehabilitation, or an insurance carrier, that is not included in the "other" categories. Expenditure for such things as work adjustment, vocational and educational preparation, counseling, tuition, books, transportation, and other related items, strictly associated with vocational training and placement are included in these expenses. The totals in Table 16 are the sums of the weighted averages for each category of expense.

Expenses accumulated in the second and third years post-injury are compiled in Table 17. As pointed out previously, in many cases, the expense in some categories is "zero". This, combined with very high expenses for a few cases in such categories as environmental modification, custodial care, attendant care, and such, tend to skew the mean and create a large standard deviation. The total in Table 17 is the sum of the weighted averages for each category of expense.

ASIA NOTE . . .

The 1980 ASIA Meeting **WILL NOT** be held in Seattle on March 30-April 2 as previously announced. As soon as final arrangements have been made for the 1980 Meeting, the location and dates will be published in both the *Model Systems' SCI Digest* and *News Briefs*.

. . . Marianne Kaplan
Illinois

**Table 16. CUMULATIVE YEAR ONE EXPENSES BY EXPENSE CATEGORY
(All Cases)**

Expense Category	Year One Expenses								
	Injury-to-Home			Balance of Year			Total		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Hospital	374	\$28,882	\$17,540	437	\$1,579	\$4,405	333	\$30,481	\$17,692
Physician	273	3,229	1,716	294	365	562	209	3,640	1,735
Equipment	327	1,661	1,768	367	497	1,007	266	2,194	2,387
Environmental Modification	394	298	1,694	373	2,065	6,090	307	2,786	7,140
Other	279	912	2,029				279	912	2,029
Total — Weighted Average Expenses	330	\$38,177							
Outpatient Therapies				321	173	417	321	173	417
Outpatient Medication/Supplies				267	527	858	267	527	858
Other Outpatient Expense				294	172	283	294	172	283
Attendant Care				442	409	1,749	442	409	1,749
Custodial Care				450	105	917	450	105	917
Vocational Rehabilitation				313	108	493	313	108	493
Other — Balance Year 1				262	372	1,558	262	372	1,558
Total — Weighted Average Expenses				347	\$6,790		312	\$42,341	

July 1979

**Table 17. POST-INJURY YEARS TWO AND THREE EXPENSES
(ALL CASES)**

Expense Category	Post-Injury Expenses					
	Year 2			Year 3		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Inpatient Hospitalization	401	\$2,435	\$5,112	358	\$1,799	\$5,894
Physician Fees	292	628	891	229	559	1,012
Outpatient Therapies	287	185	589	275	116	523
Outpatient Medication/Supplies	233	679	681	194	615	601
Other Outpatient Expense	266	216	357	254	170	259
Equipment	365	550	1,544	333	346	1,219
Environmental Modification	404	1,030	3,695	369	586	2,724
Attendant Care	450	969	3,749	401	908	2,608
Custodial Care	461	285	1,935	411	262	2,062
Vocational Rehabilitation	318	204	640	265	140	478
Other Expenses	255	462	1,160	208	453	1,334
Total — Weighted Average	339	\$8,246		299	\$6,358	

July 1979

Q11. What is the variation of expenses among neurological categories?

The utilization of services varies with the extent and level of spinal cord damage. In Tables 18-20 (pages 25-27), the breakdown of expense incurred over successive years is presented by neurological impairment. The dollar amount is particularly high for the complete quadriplegic. It must be stressed that the dollars are expressed in averages for all cases. All totals are the sum of the weighted averages.

CORRECTION

On page 16 of the Spring Issue, please correct Table 6 and the last sentence of the answer to Question 8 as shown below:

Q 8. What is the level of education at the onset of injury?

Approximately three-fourths of the reported cases had only a high school education or less. Only seven percent had a Bachelor's or post graduate degree (see Table 6).

Table 6. EDUCATIONAL LEVEL AT INJURY (3/79)

Educational Level	Cases Reported	
	N	%
8th Grade or Less	323	15
Some High School	597	28
High School Grad	769	35
Some College	312	14
Bachelors Degree	97	4
Post BA Degree	54	3
Other	26	1
All	2178	

Table 18. CUMULATIVE EXPENSES*: BALANCE OF YEAR ONE BY NEUROLOGICAL CATEGORY

Expense Category	Balance Year One Average Expenses											
	Paraplegics						Quadriplegics					
	Incomplete			Complete			Incomplete			Complete		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Inpatient Hospitalization	78	\$888	\$2,177	138	\$1,782	\$5,032	116	\$1,456	\$3,811	104	\$1,981	\$5,298
Physician Fees	49	283	328	104	459	676	74	336	557	66	313	498
Outpatient Therapies	54	203	311	113	100	178	85	277	692	68	142	271
Outpatient Medication/Supplies	47	229	309	99	632	639	66	490	965	54	644	1,266
Other Outpatient Expenses	54	165	210	102	185	269	77	145	206	60	187	421
Equipment	66	227	349	119	470	689	104	418	1,035	76	893	1,547
Environmental Modification	64	718	4,102	122	2,312	6,390	102	1,071	3,516	83	3,968	8,566
Attendant Care	77	123	577	152	69	323	114	415	1,448	98	1,157	3,198
Custodial Care	75	0	0	147	2	26	119	303	1,676	108	102	604
Vocational Rehabilitation	55	43	193	110	206	726	82	82	408	65	31	127
Other Expenses	44	320	844	91	374	961	74	168	561	52	710	3,093
Total — Weighted Average	60	\$3,026		117	\$6,105		92	\$5,094		75	\$10,106	

* Excludes initial hospitalization and rehabilitation expenses (injury-to-home).

July 1979

Table 19. CUMULATIVE YEAR TWO EXPENSES BY NEUROLOGICAL CATEGORY

Expense Category	Year Two — Average Expense											
	Paraplegics						Quadriplegics					
	Incomplete			Complete			Incomplete			Complete		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Inpatient Hospitalization	72	\$1,080	\$3,003	130	\$2,373	\$5,284	112	\$2,196	\$4,795	86	\$4,004	\$6,235
Physician Fees	44	298	455	93	726	869	80	561	945	72	791	1,021
Outpatient Therapies	51	274	1,019	98	123	328	77	204	493	59	193	550
Outpatient Medication/Supplies	40	265	425	84	814	646	67	681	774	40	778	639
Other Outpatient Expense	48	168	247	86	274	376	74	192	459	55	203	237
Equipment	64	257	682	109	634	2,054	109	597	1,558	81	614	1,189
Environmental Modification	73	320	1,813	123	762	3,291	115	1,151	4,054	92	1,810	4,650
Attendant Care	79	235	993	147	179	821	122	808	2,008	101	2,896	7,166
Custodial Care	78	96	849	144	87	788	128	440	2,358	110	501	2,801
Vocational Rehabilitation	54	249	792	105	168	594	86	192	505	72	242	731
Other Expenses	43	86	213	84	413	791	72	485	1,297	54	814	1,713
Total — Weighted Average	58	\$3,197		109	\$6,101		94	\$7,391		74	\$13,141	

July 1979

Table 20. CUMULATIVE YEAR THREE EXPENSES BY NEUROLOGICAL CATEGORY

Expense Category	Year Three — Average Expense											
	Paraplegics						Quadriplegics					
	Incomplete			Complete			Incomplete			Complete		
	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD	N	$\bar{x}$	SD
Inpatient Hospitalization	64	\$1,468	\$4,796	115	\$2,208	\$7,969	94	\$1,240	\$3,775	77	\$2,318	\$5,486
Physician Fees	41	662	1,355	73	502	653	58	483	824	49	729	1,338
Outpatient Therapies	44	120	577	95	77	306	71	195	715	57	96	521
Outpatient Medication/Supplies	35	315	319	65	834	633	47	588	715	39	609	490
Other Outpatient Expense	43	130	360	86	219	239	64	165	262	53	150	189
Equipment	61	158	341	102	306	682	91	180	509	70	501	1,007
Environmental Modification	62	5	28	119	517	1,494	101	378	1,483	79	1,472	5,259
Attendant Care	72	60	504	131	335	2,281	106	1,021	2,726	84	2,389	3,373
Custodial Care	70	20	167	131	131	934	112	465	2,794	90	410	2,898
Vocational Rehabilitation	45	137	510	90	167	534	70	139	478	53	88	347
Other Expenses	38	108	253	66	428	1,012	50	577	1,597	46	710	1,913
Total — Weighted Average	52	\$2,938		97	\$5,293		78	\$5,209		63	\$9,722	

July 1979

ARIZONA EMERGENCY MEDICAL SYSTEM

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Studies indicate that a critically ill or injured person has a 25 percent better chance of survival if the individual's condition is stabilized at the scene by professionally trained health care personnel; transported without delay to a medical facility; and given proper medical attention enroute to that facility. Delay can mean the difference between life and death.

Arizona's changeable weather, varied terrain, and rapid population growth create serious problems in evacuating and transporting critically ill and/or seriously injured patients to an appropriate medical facility. As population, industry, and traffic continue to grow, the number of serious accidents and critical medical conditions can be expected to increase accordingly.

Arizona was one of the pioneer states in developing the concept of Emergency Medical Evacuation. During the period February 1969 to June 1970, Arizona State University in cooperation with the Arizona Highway Patrol and Arizona Helicopters, Incorporated, conducted a civil Air-Medical Evacuation System (AMES) demonstration project under a U.S. Department of Transportation contract.

Actual in-flight operations with two turbine powered helicopters were conducted during the period May 30, 1969 to January 31, 1970. Under the AMES Project, communication systems (equipment) and procedures were developed and efficiently utilized. The experience, equipment and operating systems developed under the AMES Project contributed to the development of an Emergency Medical Services (EMS) Program in Arizona in the early 70's.

EMERGENCY MEDICAL SERVICES PROGRAM

In 1972, the Arizona Legislature established the Division of Emergency Medical Services within the State Department of Health; provided for the appointment of an Assistant Commissioner; ensured cooperation of private, public, and governmental agencies; adopted standards for ambulances; adopted standards and training/certification of ambulance attendants and drivers, and pro-

vided them with immunity from tort liability. They also authorized the purchase and operation of air ambulance helicopters and the establishment and operation of a statewide Emergency Medical Services Communicatins System by the Department of Public Safety.

Subsequently, the Valley Emergency Medical Services, Inc., which represents a corporate consortium of major Maricopa County health care providers, was established. This organization provided coordination of Emergency Medical Services throughout Maricopa County and developed certification criteria for paramedics; designed and implemented paramedic training programs; coordinated communication systems; and developed a five-year plan for the development of Emergency Medical Service by the Phoenix Fire Department. This plan was subsequently adopted by the Phoenix City Council. The Phoenix Emergency Medical Services was established in April 1975.

ARIZONA EMS

Recently, the Arizona Emergency Medical Systems, Inc. was established. This organization is funded in part by the Division of Emergency Medical Services, U.S. Public Health Service, to coordinate all emergency medical service activities throughout the state and to serve in an advisory capacity to State, County, and City EMS programs.

Basic and Advanced Life Support Systems (BLS/ALS) have been developed for the 1,410,075 persons residing within the 19,424 square miles of the three-county Central Arizona Region (Phoenix). Fifty-six percent of the region's population reside in the metropolitan Phoenix area. In this metropolitan area, 93 percent of the total population is serviced by ALS/BLS.

The 101 paramedics now providing ALS services in metropolitan Phoenix are supervised by 12 base station hospitals through a coordinated Medical Control System. The rural sections of the region, which include 95 percent of the land area and 7 percent of the population, are serviced by BLS. Several more populated areas are now receiving intermediate EMT response to medical emergencies.

Conditional vertical categorization for head and spinal injuries resulted in the designation of two Level I, two Level II, and eleven Level III medical facilities. The Southwest Regional System for the Treatment of Spinal Injury (SWRS), located in Phoenix, services the State of Arizona and neighboring states. Approximately 50 percent of the patients admitted to the Spinal Cord Injury Center are residents of Central Arizona; about 30 percent of the patients are residents of the other Arizona regions; and the majority of the remaining 20 percent are residents of neighboring states.

The formalized categorization process is now underway with modified National guidelines being used for procedural criteria. The designation process, including site-visit validation, was completed in 1978. Transfer and treatment protocols have been written and approved by professional agencies. Triage protocols have also been developed.

Although no formalized protocols exist in the system, Basic and Advanced EMTs have received excellent instruction in extrication and immobilization procedures for individuals with suspected spinal column injuries. In addition, emergency personnel have been informed of appropriate hospitals for the care of such persons. In the region, there are 14 neurological intensive care beds which were 66 percent utilized in 1977.

Throughout the development of the Emergency Medical Program, the Southwest Regional System for Treatment of Spinal Cord Injury has provided professional leadership, technical assistance, and training. The Barrow Neurological Institute has become the major receiving hospital for the acute spinal cord injured.

AIR EVAC PROGRAM

As early as 1969, Samaritan Health Services recognized the need for the rapid transportation of the critically ill, or seriously injured, from outlying areas to a major medical facility. At that time, AIR EVAC was established by Samaritan Health Services — using fixed-wing aircraft — as an air ambulance service to provide a rapid, medically supervised, transportation for patients from the outlying regions of the state. AIR EVAC is the only hospital-based, physician-directed air ambulance service in the state approved by the Arizona Corporation Commission.

Ground ambulances and fixed-wing aircraft are doing a good job but the growth in the Phoenix area has simply exceeded the emergency medical transportation capabilities of these services. Unfortunately, crowded freeways and congested street traffic can obstruct and thus slow the passage of emergency ground transportation. During peak traffic periods, emergency vehicles may require an hour or more to reach a major medical facility from some of the outlying areas of the state.

To meet the vital need for an expanded air transport service, Samaritan Health Services and John C. Lincoln Hospital combined their efforts early in 1979 to provide a 24-hour-a-day emergency helicopter transport service. This new transport service was integrated into AIR EVAC's fixed-wing operations and designated the Helicopter Division of AIR EVAC. This new service provides rapid transportation within Arizona for medical emergencies — particularly those in remote areas that are not accessible to fixed-wing aircraft, or in congested city traffic when time is critical and ground transportation may be too slow.

AIR EVAC FIXED-WING

AIR EVAC is a non-profit, hospital-based, fixed-wing air ambulance service operating out of Phoenix, Arizona, at Sky Harbor International Airport. All flights are under the supervision of a physician and carry an on-board flight-trained Registered Nurse. The pilots, all of whom are airline-qualified, have received additional training in medical evacuation and patient handling.

The aircraft is specially prepared and equipped for each flight in accordance with the patient's needs. Nearly any type of patient — including spinal injury, premature infant, expectant mother, cardiac or orthopedic — can be safely transported. Inflight monitoring, respiratory assist, and intravenous medication administration by flight-trained Registered Nurses are among the support services provided.

Any licensed physician can order this air ambulance service with one telephone call. All other arrangements such as ground transportation, medical records transfer, hospital admittance and other paperwork and coordination, are handled by Air Evac personnel. The airplane and crew, with the proper equipment aboard, can be airborne within 30 minutes of notification, anytime day or night, seven days a week.

All of the patient flights are under the direct supervision of a physician who has had special training in Aviation Medicine, and a paramedic coordinator, also trained and familiar with the special needs of airborne medical care.

AIRCRAFT: After years of experimentation with various types of aircraft, Air Evac found the Cessna 400 series twin-engine airplanes the best suited for almost every type of medical air transport. Only the latest, most up-to-date equipped aircraft are used by Air Evac. The Cessna 402 has ample room to carry two patients, plus flight and medical personnel as well as medical supplies and equipment. Family members of the patient are allowed to accompany the patient with the physician's approval. The aircraft is equipped with modern avionics and navigational instrumentation.

Because of its size and versatility, the Cessna 402 is capable of landing at nearly every licensed airport in the country — more than 12,700 in all. It is not restricted to the busy, commercial airports in metropolitan areas.

MEDICAL: Every Air Evac flight carries respiratory equipment, a sealed drug kit with more than 30 drugs, including I.V. solutions. Special patient monitors are also available when necessary. For orthopedic patients, including spinal injury, Air Evac has available many special types of devices, including traction and a Striker Frame. Other medical equipment includes: incubators for infants, naso-gastric suction, naso-pharyngeal suction, positive pressure breathing devices, cardiac monitor and defibrillator.

LIABILITY: Air Evac is licensed as an extension of the Emergency Department of Good Samaritan Hospital, Phoenix, Arizona, and as such is fully covered for liability as an Emergency Department.

AIR EVAC HELICOPTER

The Air Evac helicopter — based at the two sponsoring hospitals, Good Samaritan and John C. Lincoln, on an alternating basis — can be airborne within three to five minutes after a "service" call is received.

The aircraft, an Alouette 316B, is essentially an airborne emergency room designed to transport the critically ill and injured from outlying areas to medical (or health) care centers in Phoenix. The new service is designed for "*primary pickups*" such as responding to the scene of an accident; for emergency use in areas that do not have adequate facilities to land a fixed-wing aircraft; and, to transport patients from one hospital to another.

The AIR EVAC Helicopter service differs from the Arizona Department of Public Safety helicopter program in that AIR EVAC's first priority is full-time emergency medical transport with specially trained Flight Nurses on board.

The Alouette helicopter was selected for its superior performance under all types of flying conditions. It has a proven record in the thin atmosphere of the world's toughest mountain ranges as well as the hot, dry climates of the desert, where high temperatures can keep a lesser craft on the ground.

The Alouette is larger than conventional air-ambulance helicopters and can fly at an altitude of up to 18,000 feet — transporting two patients, two attendants and all necessary life support equipment. Yet, it is small enough to operate in and out of very confined areas. An area only 60 feet in diameter, clear of wires, trees, emergency vehicles, trash cans, signs and twigs is required for landing (100 feet is needed when high winds are a factor). Its rotary blades can come to a full stop within 45 seconds of landing. Less maintenance is required by the Alouette than most conventional helicopters.

The Helicopter Division of AIR EVAC is designed to augment the team effort of law enforcement, public safety departments, fire departments, emergency medical service agencies, physicians, plant safety and security authorities and hospitals by delivering critical care in medical emergencies. These are the only agencies or individuals that may request an AIR EVAC helicopter.

The AIR EVAC helicopter can be placed on "standby alert" at the request of a law enforcement officer, or Emergency Medical Technician, while enroute to any emergency at which serious injuries can reasonably be expected. When notified that the helicopter is needed at the emergency site, the craft can be off the pad in less than a minute. This procedure minimizes the helicopter response time and could help save an accident victim's life.

Registered Nurses who specialize in emergency care are assigned to the helicopter to administer lifesaving care at the accident scene and enroute to the hospital. The Flight Nurses are experi-

enced in recognizing life-threatening conditions and taking appropriate action. Examples of life-saving procedures which can be administered at the scene or in-flight include endotracheal intubation, cricothyroid sticks (to assist in breathing), identification and treatment of cardiac arrhythmias.

At all times, a team of physicians, including surgeons and other specialists, is standing by in the largest and best equipped medical facilities in Arizona. Because AIR EVAC is backed by the largest medical organization in the Southwest, it is able to draw on the talents and experience of personnel in almost every area of medical specialization and sub-specialization. This includes respiratory therapy, spinal injury, cardiac care, perinatal, pediatrics, and anesthesiology, among others. This resource is invaluable and irreplaceable in those special cases that require it. No other air ambulance organization has such broad resources immediately available to it.

The Dispatch Center maintains constant in-flight communication with the flight crew when AIR EVAC is on a mission. During a flight, the flight attendant can communicate by radio with a physician in the emergency department of any hospital and request any additional medical services that might be needed by the patient upon arrival. The sophisticated dispatch capabilities of the system also allow the receiving physician to telephone the Dispatch Center and speak directly to the attendant in the helicopter.

This emergency helicopter transport service is similar to successful programs now operating in Denver, Houston and Pensacola, Florida. The shared service is available to all hospitals and other authorized agencies on a 24-hour/day basis.

HELICOPTER OR FIXED-WING

The specific craft to be used in any given situation is based on medical opinion, location, and medical condition of the patient. Generally, the helicopter will be used for distances less than 100 miles, and the fixed-wing aircraft for distances over 100 miles. The helicopter has a 130-mile radius and can be dispatched on longer missions when needed, but only with the permission of the Flight Director in concurrence with the Medical Director. This service provides for prompt evacuation of emergency spinal cord injury cases from outlying hospitals to the Barrow Neurological Institute and Good Samaritan Hospital.

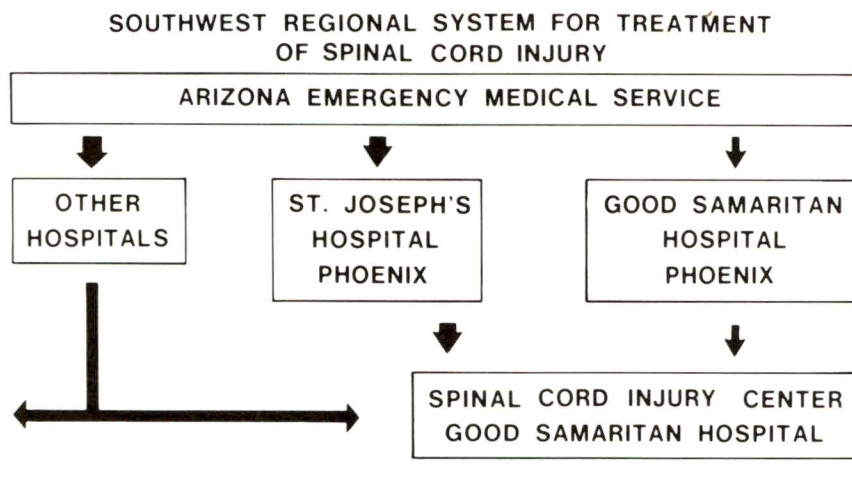
SUMMARY

The development of the Emergency Medical Service in Arizona resulted in a marked increase in the number of direct admissions from the accident site to the Barrow Neurological Institute and prompt evacuation from other receiving hospitals as soon as the diagnosis of spinal cord injury was made. This evolutionary process resulted in early admission of the majority of patients to the SWRS. Approximately 60 percent of the cases treated in the Spinal Cord Injury Center at Good Samaritan Hospital were admitted to the SCI System either via Barrow Neurological Institute or Good Samaritan Hospital. Of those admitted from these two sources, approximately 90 percent come from Barrow and 10 percent from Good Samaritan. Seventy percent of the cases admitted to the SCI System via this route were admitted within 24 hours of injury. The mean for this group was 6.4 hours. Fifteen percent of these were admitted directly to Barrow Neurological Institute from the accident site. The remainder usually had a short emergency admission in a receiving hospital with a prompt referral following the diagnosis of spinal cord injury.

The remaining 40 percent of the cases admitted to the SWRS at Good Samaritan were referred from hospitals other than St. Joseph's or Good Samaritan. Approximately half of these came from

Arizona hospitals and the remainder from out-of-state hospitals. Referrals from these sources are usually delayed, and arrive at the SWRS four to eight weeks after injury.

As a result of these and other ongoing developmental programs, the State of Arizona currently has a modern Emergency Medical Services Program, which though still undergoing continued development, has become a model unto itself.



Featured Article — EMT. . .

TYPE OF EMERGENCY/RESCUE VEHICLES

Some ambulances now in use are inadequate to handle spinal cord injured patients and others with severe trauma. The ideal ambulance should be wide enough to carry two litters side by side and high enough so attendants may stand without being cramped to administer positive pressure respiration assistance, start intravenous fluids and make a more thorough evaluation of the patient's condition. Larger ambulance bodies will also allow patients to be transported in traction on Stryker Frames.

SUMMARY

As with all trauma patients, the spinal cord injured victim must be evaluated, initially, in terms of adequacy of airway, hemorrhage or excessive bleeding and finally immobilization requirements . . . that is, the "ABC's" of life support, airway, bleeding and circulation, must be considered and appropriate treatment instituted. Suffice to say, the Emergency Medical Services provided at the accident scene and during evacuation will in many, if not most, instances directly affect the patient's course of recovery and in some instances his ultimate survival.

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Featured Guest . . .

The photographs and description of the device that is used for "walking" indicate that this is no different from the device demonstrated by Dr. Gordon Murray in his disclosures in the 1960s. *The patient does not walk*; he is held erect on auxiliary crutches, his knees are caged, his hands are placed on parallel bars, and forward locomotion is achieved by therapists pulling on thongs attached to his shoes. The upright position has been recognized as useful for a number of years but instead of this particular apparatus, the U.S. tends to use tilt tables. However, the word "walking" has a certain magical ring to it and its symbolic importance to the individual cannot be minimized.

No one who has worked with the spinal injured would wish other than that there be found — whether in the chemical library or in the enzyme family or a new mechanical or surgical process — some means to restore function to damaged central nervous system tissue. When all the evidence available to date is examined critically, however, the only conclusion that can be reached is that that day is not yet here. Rather than splinter off yet another agency — such as is being proposed by the three gentlemen who have been to Russia — they might consider joining forces with existing public and private agencies working toward this much hoped for goal. Combined with the already extensive endeavor of the NINCDS and the Research Division of the SCI Foundation, as well as many University efforts, potentially bigger rewards for the funds available are likely to be realized should this, and other splinter groups, join the main stream of programs now in progress.

Until such time as central nervous system regeneration is possible, we must all be prepared to accept the fact of both false claims and, as appears the case here, lay press misinterpretation of complex situations. We must also continue to strive for the highest quality clinical care for those living with these injuries. Hints of miraculous cures are cruel jokes to spinal injured individuals who need to receive the best treatment available and then get on with their lives.

From the Data Bank . . .

variance problem, thereby, permitting meaningful statistical analysis. Out of this logical need, the National ("Common") Data Base was born. The honeymoon was over. The Regional SCI Systems, joined together in matrimony, got down to the nitty-gritty of co-habitation.

Over the course of several conferences held in Houston (1972), Chicago (1973), Washington, D.C. (1944) and Virginia (1975), a common data base was tediously and arduously developed. Research questions to be answered were defined. Some were specifically clear, while others were somewhat ambiguous. Data to answer these questions were selected on the basis of collectibility, reliability (objectivity) and relevance.

The process of variable selection was haunted by the realization that pooled data on all patients must of necessity be standardized and, as a consequence, would be relatively superficial. Specific clinical questions relating to the efficiency of therapeutic techniques would have to await carefully defined indepth protocols. The "common data base" must be limited to objective data documenting such things as demography, epidemiology, and medical, social and vocational events, over time, following the injury.

The research questions to be answered are many. *What services are needed and provided over time? What are the problems encountered by the spinal cord injured? And, how well are they able to cope with them?* Lastly, and of key importance to the Model Systems' project: **WHAT ARE**

THE MEDICAL AND SOCIAL COSTS OF SPINAL CORD INJURY? WHAT IS THE COST EFFECTIVENESS OF A REGIONAL SYSTEM OF SPINAL CORD INJURY CARE?

Reaching a consensus of the Regional Model System's representatives as to which variables were to be included in the common data base was a tedious process. However, that was only the beginning. The next chore was to write a Syllabus carefully defining each variable so there would be standardization of data originating from multiple sources. I personally was unprepared for the unimaginable pitfalls encountered during this process. At the onset, it seemed comparatively simple. The Queen's English, particularly when written by Americans, is fraught with potential misinterpretation or multiple interpretation. For example, we decided it would be nice to know how many children the injured person had. This seemed straightforward and could be reported by a discrete number. However, there were definitional problems. What do we mean by children? Only those living? Do we include those who are now adults? What if they are adults but are still supported by their injured father? What is the cut-off age, 16? 18? 21? How about foster children or step-children? Wouldn't it be better if we changed "children" to "dependents"? Thus it went, on and on and on! The writers of the Syllabus, representing all of the Model Systems, received a liberal taste of what went into writing the Talamund.

Finally, after literally hundreds of hours of deliberation and compromise, the Syllabus was completed and the reporting methodology established. Designing the report forms themselves was no little chore. Programming the data bank files to handle multiple data bases over time was a complex exercise in itself. Eventually all things were accomplished and data collection began — a gratifying achievement for all concerned.

Our smug complacency was short lived! As the data accumulated, it became frustratingly apparent that there were still "flaky" definitions for a few variables. Further, data is collected, reported and encoded into the computer by human beings. Errors can and do occur throughout the process. Even the computer is capable of an occasional goof. The "dirty data" gremlins had been hard at work. Obviously, the data needed to be cleaned up.

Mrs. Ann M. Peters, Data Collection Manager, assisted by the staff of the National SCI Data Research Center, carefully reviewed over 1000 cases, identifying over 300 variable correlations that could be checked by the computer. A "Discrepancy List" program was entered into the computer to meticulously check the reported data for errors. For example, the date of admission must be later than the date of injury. If a case was coded as a quad in one variable, the level of injury recorded in another variable should be cervical. Days recorded on each individual hospitalization record must equal the total days hospitalized for the year being reported. Such correlations were identified.

The result was a computer printout entitled the "Discrepancy List" which is mailed periodically to the individual SCI Systems. The initial list was somewhat less than joyously received by the reporting Systems. Their frustrations and irritations were somewhat relieved, however, by the opportunity to gleefully report errors that resulted from goofs at the National SCI Data Research Center. After a painful and laborious process of data updating, the "dirty data" was purged from the National SCI Data Bank. The original Discrepancy List contained an average of 1.7 errors per report form. This was reduced to 0.3 — primarily representing the turn-around time in the up-date process.

The result of this joint effort was the establishment of the National Spinal Cord Injury Data Bank. As of July 24, 1979, data for 4027 cases of traumatic spinal cord injury, occurring since 1973, are in the Data Bank.

Within the limits of its design, the National Data Bank has become a valuable resource for information pertaining to spinal cord injury. This Data Bank will become increasingly valuable as data, reflecting events occurring over the years following injury, are accumulated.

STATUS OF NATIONAL DATA BANK
(as of JULY 24, 1979)

	ENTRIES TO-DATE	
INJURY YEAR (FORM I)		
1973	232	
1974	488	
1975	697	
1976	820	
1977	956	
1978	799	
1979	35	4,027
FOLLOW-UP YEAR (FORM II)		
Year 1	2,429	
Year 2	1,859	
Year 3	1,269	
Year 4	703	
Year 5	283	
Year 6	58	6,601

"Let's collect some data." How naive we were at the front end as to what this seemingly rather innocuous suggestion entailed. However, the result has been more than worth the effort. The National Spinal Cord Injury Data Bank is a gold mine of information. The descriptive statistics presented in this and the Spring Issue of the *Model Systems' SCI Digest* represent only a preliminary panning of the alluvial sands. The mother lode awaits extensive hard rock mining by the process of meticulous statistical analysis, evaluation and publication of the cumulative results.

All of the Model SCI Systems that joined in the creation of the National Spinal Cord Injury Data Bank are now participating in the analysis and information dissemination process. The *SCI Digest* provides a media for the timely publication of information as it is developed. In addition, the Data Bank is spawning a plethora of scientific papers written by the staff members of all the Model Systems for publication in a variety of professional journals. The ultimate results will be a significant advance in our understanding of the implications of spinal cord injury.

... John S. Young, MD
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Craig Hospital
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So. Florida Regional SCI System
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School of Medicine
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Midwest Regional SCI Care System
Northwestern Memorial Hospital
Rehabilitation Institute of Chicago
Northwestern University
McGaw Medical Center
Chicago, Illinois

Northeast Regional SCI System
University Hospital of Boston
University Medical Center
Boston, Massachusetts

Missouri Regional SCI System
University of Missouri
School of Medicine
Columbia, Missouri

New York Regional SCI System
Institute of Rehabilitation Medicine
New York University
New York, New York

Regional SCI System of Delaware Valley
Thomas Jefferson University
Philadelphia, Pennsylvania

Texas Regional SCI System
The Institute for Rehabilitation and Research
Houston, Texas

Virginia Regional SCI System
Woodrow Wilson Rehab. Center
Fishersville — University of Virginia
Charlottesville, Virginia

Northwest Regional SCI System
University of Washington
Seattle, Washington